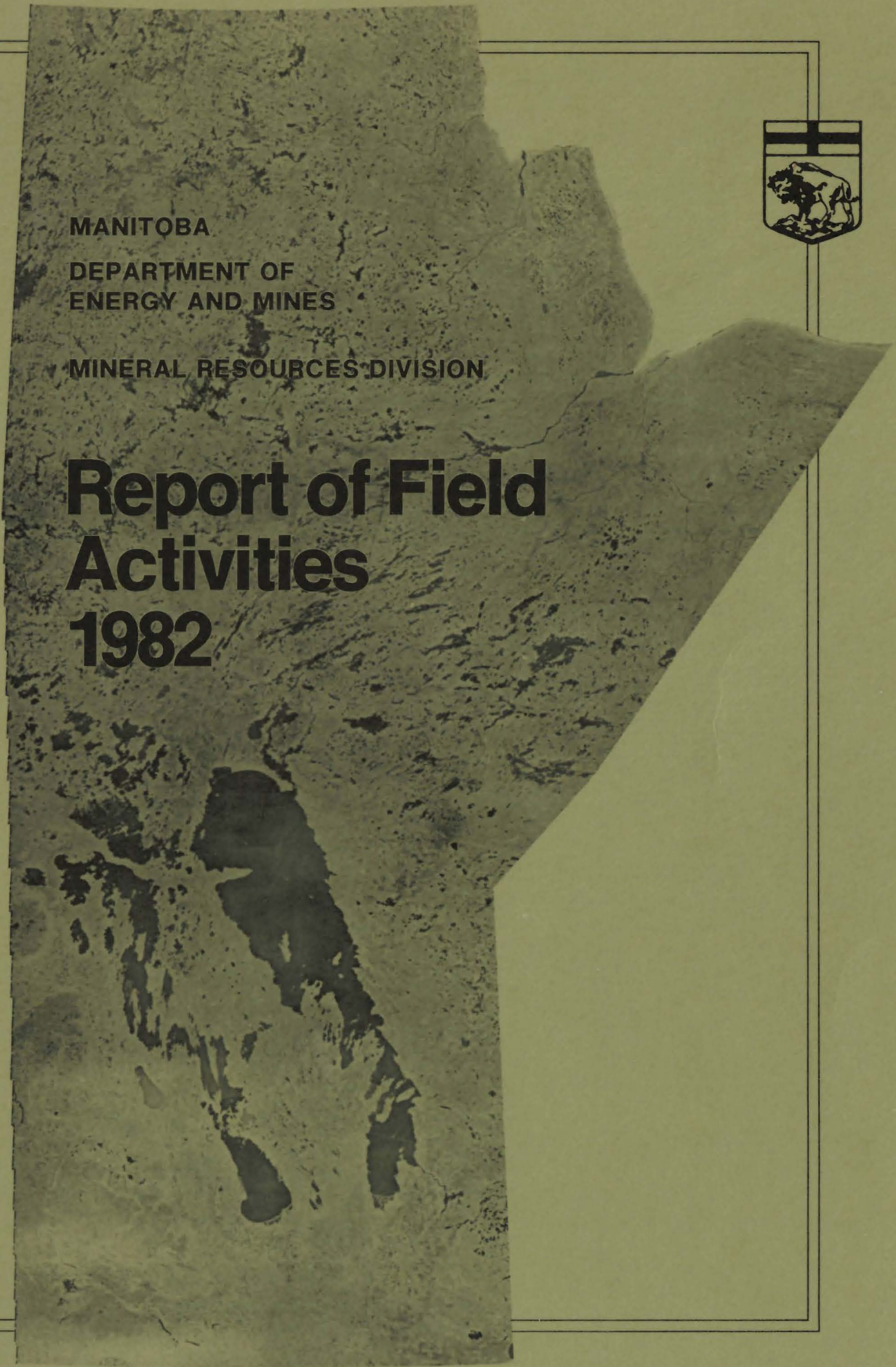
MANITOBA

DEPARTMENT OF
ENERGY AND MINES

MINERAL RESOURCES DIVISION

Report of Field Activities 1982



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GEOLOGICAL SERVICES BRANCH

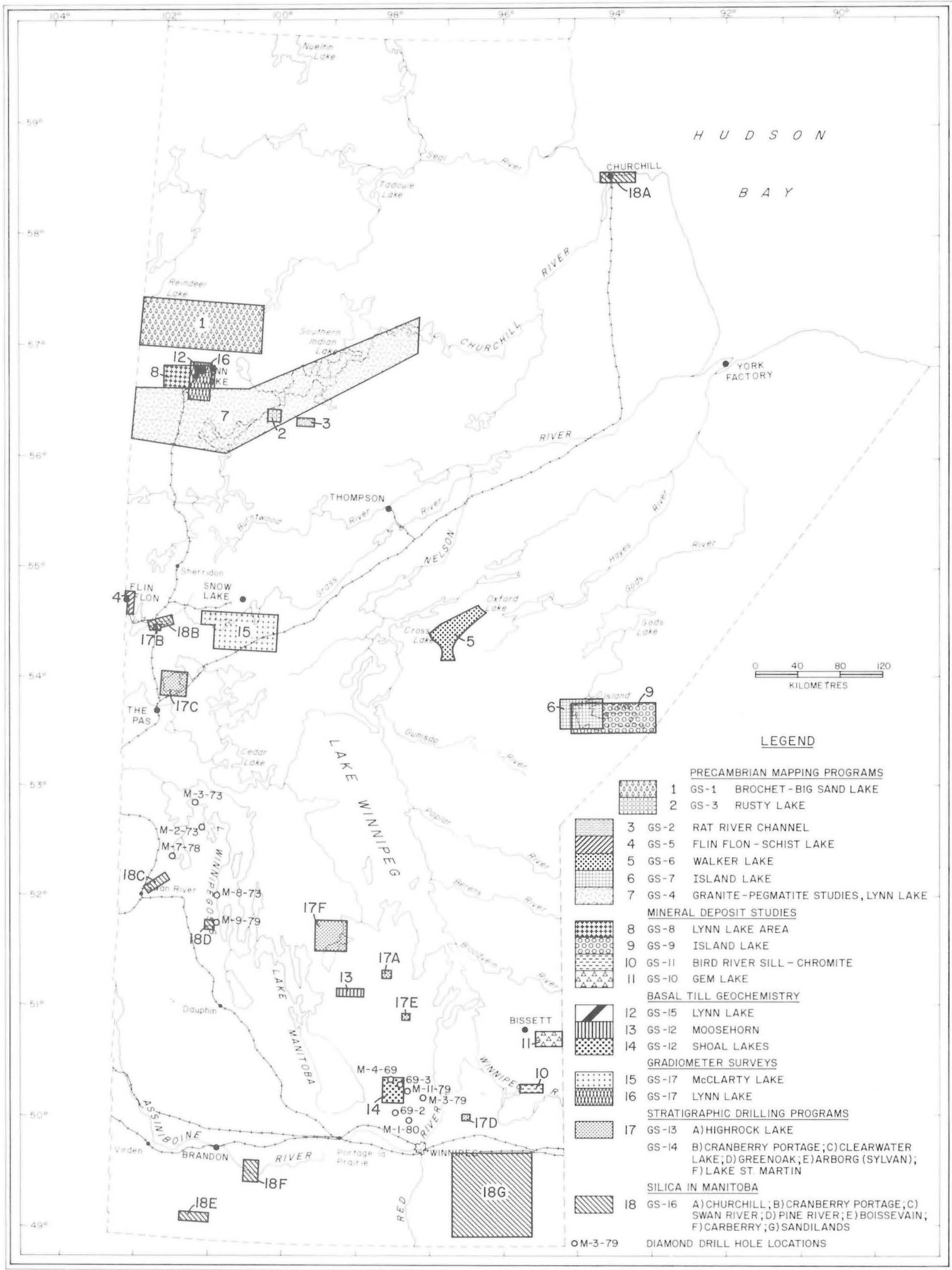


Figure GS-1: Location of Field Projects 1982

SUMMARY

by W.D. McRitchie

A total of 17 major field projects were mounted by the Geological Services Branch in 1982 in addition to numerous short-term investigations into mineral deposits, industrial minerals, and geological data-gathering related to compilation programs. The overall objective of the Branch continues to be the generation of geoscientific and mineral deposit data that will ensure the optimum utilization of the Province's rock and mineral resources.

Close co-operation has been maintained with the Geological Survey of Canada in undertaking projects related to strategic minerals concerns, geophysical surveys and a concentration of effort in the Lynn Lake region.

Although this report emphasizes the work and findings of the field programs, additional data and information are also being generated through co-operative research with staff and analytical laboratories at the Universities of Manitoba, Alberta, Carleton, Montreal and Windsor. Assistance is also being provided to NASA geologists from the Lyndon B. Johnston Space Centre in Houston who are conducting research into terrestrial anorthosites for comparison with those from the moon.

Branch activities were intensified at Lynn Lake as part of a multi-faceted program intended to stimulate and provide guidance to exploration in the region, and accelerate the evaluation of the district's residual mineral potential. Considerable assistance was provided by company personnel, especially Sherritt Gordon Mines Ltd.

Jointly funded Federal/Provincial aeromagnetic gradiometer surveys in the McClarty Lake (Snow Lake) region (12 000 line km) were extended to include a 4 000 km pilot study over Lynn Lake in order to determine whether the technique would provide better geological control than could be obtained from the 1976 aeromagnetic data. The results of these surveys will be released in March 1983 and November 1982, respectively, priority in processing having been given to the tapes from the Lynn Lake survey.

Mineral deposit studies focussed on a re-evaluation of drill core from the immediate Lynn Lake area and resulted in the identification of mineral assemblages diagnostic of alteration pipes, metal zonation, key stratigraphic sequences and lithologies diagnostic of exhalative mineralization. Basal tills, down-ice from the Agassiz deposit, were sampled with a backhoe to test the usefulness of this technique in the search for base and precious metals. These studies were augmented by extensive lithogeochemical sampling of this deposit and the Lynn Lake rhyolite.

Detailed geological mapping has been conducted in the region since the announced closing of the Farley Mine in 1976 and is now virtually complete. Brief surveys were conducted in the Rusty Lake area and east of the Rat River channel bringing to a conclusion the upto date 1:50 000 scale geological coverage of the greenstones from Saskatchewan to east of Karsakuwigamak Lake. The second year of more regional mapping immediately to the north in the Brochet/Big Sand area confirmed the widespread extent of paragneisses and granitic intrusions north of the Lynn Lake belt, identified an important 275°-trending linear zone of cataclasis, mylonitization and associated pseudotachylite running through Le Clair Lake, and confirmed the suspected occurrence of high grade recrystallized volcanic rocks in the Paskwachi Bay region.

An evaluation of the granites and pegmatites between Thorsteinson Lake and Tod Lake indicated little if any potential for rare elements and related minerals other than minor occurrences of tourmaline and beryl.

The Geological Survey of Canada joined with the Manitoba Survey in mounting a geochronological uranium/lead zircon study of key units in the Lynn Lake belt. The GSC also undertook, on a trial basis, several ground EMP surveys near Lynn Lake as part of a more wide-ranging study of deep conductors to be continued in 1983.

In the Flin Flon belt detailed geological mapping near Schist Lake confirmed the widespread occurrence of subaqueous volcanic flows, and repeated faulting which constitutes a major impediment to a stratigraphic synthesis of the area. Notwithstanding the complexity of the structure and difficulty in correlating between fault blocks, extensive zones of hydrothermal alteration (silicification, etc.) are interpreted to indicate a high potential for additional occurrences of base metal mineralization.

Geological mapping at Island Lake, in the Superior Province, was conducted partly in support of detailed geochemical sampling and mineral deposit investigations of the gold occurrences in the area. A significant discovery was the identification of thick turbidite sequences overlying the basal conglomerates of the Island Lake Group.

Mapping at Walker Lake delineated the western limits of the God's or Oxford Lake Belt greenstones and provided additional data confirming the regional structural interpretation by Hubregtse (1979) and the gradational relationships between the Superior Province and Pikwitonei granulites. Rare element pegmatites similar to those on Cross Lake were not encountered.

In southeast Manitoba the base metal potential and possible exhalative association of felsic volcanic rocks at Gem Lake was evaluated, and detailed channel sampling was conducted across the Bird River Sill, and on selected properties, as part of a platinum metals group and chromite resource evaluation being conducted with the co-operation of the GSC.

Additional basal till and soil samples were collected in the southern Interlake area to determine the source area to rare float galena pebbles, another of which was identified in the Swan River area this spring. A geochemical study of Paleozoic drill core is also being conducted as part of this program.

An inspection of sands at Churchill, Boissevain, Swan River, Black Island, the Whiteshell, south of Delta and in other areas completed a two-year evaluation of silica resources in the Province. Final report production is scheduled for mid-1983.

The Branch's stratigraphic drilling program provided much new data on the High Rock Lake Precambrian inlier, and a prominent linear gradiometer anomaly south of Cranberry Portage. At High Rock Lake the drilling has enabled the reconstruction of a probable impact crater in which distinct "tectonized" zones can be provisionally delineated including an excavated central crater zone with a possible relief of up to 500 m.

Several additional holes are planned in six test areas (including Greenoak, Sylvan, Lake St. Martin and Dawson Bay) that will provide reference data for shallow seismic surveys being conducted by the GSC as part of their evaluation of the "optimum window reflection seismic technique".

The joint annual meeting of the Geological Association of Canada and Mineralogical Association of Canada (May 17-19) was hosted by the Department of Earth Sciences, University of Manitoba, in Winnipeg. Branch staff assisted in the organization of the meeting and led field trips to points of geological and mining interest both before and after the meeting. Several of the trips were re-run, at the request of exploration geologists, at various dates throughout the summer.

The stimulating exchange of concepts and perspectives between geologists of diverse backgrounds, in the field and at such conferences, continues to provide new insight into joint concerns and has in several instances resulted in significant changes to the focus of future programs.

GS-1 BROCHET — BIG SAND PROJECT

(NTS 64F)

by D.C.P. Schledewitz and H.D.M. Cameron

INTRODUCTION

1:100 000 scale mapping of the Southern Indian Gneiss Belt (McRitchie, 1977) was concentrated in the areas of Paskwachi Bay, Wells Lake and Le Clair Lake by D. Schledewitz, and by H.D.M. Cameron in the Gold Sand Lake and the Paskwachi River region (Map 1982M-1). Mapping at a reconnaissance scale was also carried out in the southern half of the Brochet (NTS 64F) map-area using fixed wing and helicopter support.

GENERAL GEOLOGY

Bedrock exposures in the Paskwachi Bay area provide the most completely preserved sequence of geologic events observed in the region. The suites of rocks observed are:

1) metavolcanic rocks (basic to acid?);
2) biotite-rich to quartzo-feldspathic paragneisses;
3) gneissic diorite to hornblende-biotite migmatite;
4) amphibolites, meta-gabbro, meta-basic rocks in part zoned;
5) biotite + magnetite tonalite to quartz monzonite;
6) meta-diorite, metadiabase, metabasic dykes (zoned in part);
7) granite, granite pegmatite and aplite.

Recognizable metavolcanic rocks are rare and only locally preserved. They occur in a wedge-shaped area southwest of Paskwachi Bay (Fig. GS-1-1); pillow-like structures can be observed. The composition appears to be andesitic. Flanking these occurrences are more thinly layered intermediate to basic layers of possible flow material. Other outcrops of metavolcanic rocks in this area are more massive meta-basalts and thin layers of fine grained quartzo-feldspathic rocks of rhyolitic composition.

The paragneisses comprise a variable suite of mainly fine to medium grained quartzo-feldspathic rocks which exhibit a granoblastic texture. The paragneissic suite comprises:-

i) light grey-biotite (5-8%) – feldspar-quartz (25%);
ii) light grey-biotite (8-10%) – garnet (2-5%) – feldspar-quartz (25%);
iii) dark grey biotite (10-20%) – garnet (2-5%) – feldspar-quartz (20%);
iv) dark grey biotite (15-20%) – feldspar-quartz (20%);
v) grey biotite (8-12%) – garnet-magnetite + black acicular amphibole (1%);
vi) quartz-rich granoblastic rocks with quartz in excess of fifty per cent;
vii) grey buff biotite (8-10%) – feldspar-quartz (25%) with lenticular zoned magnetite porphyroblasts (magnetite cores with feldspar-quartz coronas);
viii) thinly layered amphibolite (2 mm to 3 cm) and grey fine grained to medium grained quartzo-feldspathic layers with 3-5% biotite.

Highly garnetiferous zones, with thirty to eighty per cent garnet, occur sporadically within these rocks. The garnetiferous zones may contain magnetite and/or pyrite and can be layered to massive. The matrix material is feldspar and/or quartz and, less commonly, calc-silicate minerals.

Only large-scale primary structures are observed, such as a layer comprising blocks of intermediate to basic composition in a biotite-feldspar-quartz matrix. This layer occurs within an area of biotite-garnet-paragneiss to migmatite. It is uncertain if the coarse fragmental is a distal volcanogenic conglomerate or a debris flow. The lack of facing criteria within the paragneissic suite is a major obstacle that prevents a stratigraphic interpretation and synthesis at this time.

The age relationships of the metavolcanic rocks and paragneisses are as yet unknown; however, both rock types have been intruded by gabbro, and basic dykes, and sills. Numerous amphibolite and metabasic lenses are present within the paragneisses of Paskwachi Bay. Pyrite and trace chalcopyrite mineralization occur within and on the flanks of several of the metabasic lenses. The highly garnetiferous zones within the paragneisses appear to occur in areas where the mafic to amphibolite lenses are most heavily mineralized and abundant. Zones of mineralization are shown in Figure GS-1-1 and assay results are listed in Table GS-1-1.

The metavolcanic rocks and paragneisses of Paskwachi Bay lie within an area of gneissic diorite, hornblende-biotite migmatite and medium- to coarse-grained biotite + magnetite-tonalite to quartz monzonite (Fig. GS-1-1). The gneissic diorite occurs in the northern part of Paskwachi Bay and gives way to biotite-granite gneiss and pale pink coarse grained hematitic monzogranite at the extreme north end of Paskwachi Bay. An intrusive complex of gneissic diorite, and hornblende-biotite-migmatite intruded by a vein network of light grey foliated biotite-tonalite to quartz monzonite, lies along the west side of Paskwachi Bay and appears to extend into Saskatchewan. The southwest end of Paskwachi Bay is underlain by a zone of grey foliated to laminated tonalite to quartz monzonite containing inclusions of paragneiss and gneissic diorite. Gneissic diorite inclusions dominate to the south.

The rocks lying immediately south of Paskwachi Bay are a complex of foliated coarse grained biotite (8-12%) + garnet-tonalite with large and small inclusions of mainly biotite + garnet-graphite-feldspar-quartz gneiss and, less common, layered amphibolite and/or metabasic lenses. These rocks are all intruded by coarse grained to locally pegmatitic white leucocratic monzogranite.

The age relationships of the gneissic diorite and hornblende-biotite-migmatite to the metavolcanic rocks, paragneisses and metabasic lenses is uncertain. However, all previous rock types have been intruded by large-scale intrusions of the grey biotite + magnetite-quartz monzonite to tonalite. These rocks were subjected to a phase of deformation and metamorphism prior to the intrusion of a suite of diabase, gabbro to diorite dykes, and discrete small plutons. A second phase of deformation and metamorphism followed the intrusion of these basic rocks. This phase of deformation was accompanied by intrusion of monzogranite, pink granite, pegmatites and aplites. Major shearing, faulting and potassium metasomatism accompanied this stage of tectonism.

Le Clair Lake

The paragneisses at Le Clair Lake, in the extreme east central part of the Brochet-Big Sand Project area, are in part similar to the paragneisses at Paskwachi Bay (Fig. GS-1-2). In addition this suite of paragneisses contains a zone of disseminated sulphides approximately 9 km in length and approximately 400 m in width. The suite of paragneisses comprise:

i) grey biotite (10%) + garnet + cordierite + pyrite-feldspar-quartz (20-30%);

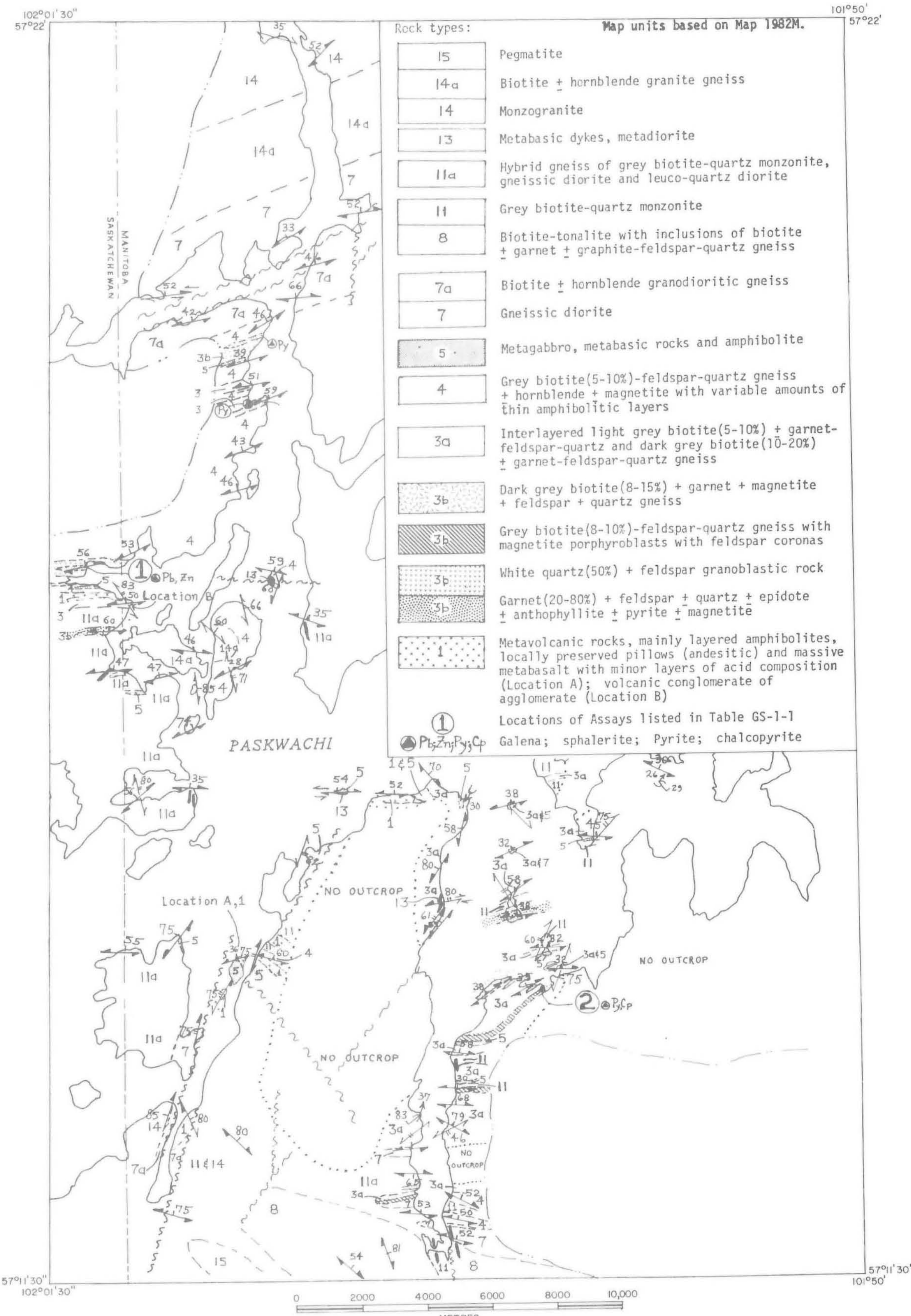


Figure GS-1-1: Outline geology of Paskwachi Bay. Reindeer Lake.

Ag, Au - oz/ton

Cu, Zn, Pb, Ni - %

TABLE GS-1-1: MINERALIZATION

Map Location Number	Rock types and Mineralization	Assay						Previous Work
		Cu	Zn	Pb	Ni	Ag	Au	
#1 Fig. GS-1-1	Anthophyllite to diopsidic mafic sills containing seams of galena and chalcopyrite, pyrite. Pyrite also occurs disseminated in partly silicified biotite-garnet paragneiss on margins of sill and in pegmatites							Work is reported in Manitoba Mineral Resources Open File under Accession Nos. 90189, 90190 and 92144. A diamond drilling program was carried out in 1928 which reported zinc values; ground EM and diamond drilling were carried out in time period from 1963-65 (Parres-Ramsey Option). Diamond drilling reported zinc values from 0.2 to 5.1%, Cu at 0.1 and silver at 0.1 oz/ton. However, these were over small intervals - 0.2 m to 14 cms - and erratic in occurrence. Ground EM and mapping were carried out by the Exploration department of the Manitoba Mineral Resources Division.
#2 Fig. GS-1-1	Zoned gabbro to ultrabasic sills and amphibolite-pyrite, pyrrhotite, trace chalcopyrite; lenses of pegmatite and silicified biotite-garnet-feldspar-quartz paragneiss, disseminated pyrite	0.03	0.01	0.01	0.01	0.03	Tr	NONE
#3 Fig. GS-1-2	Biotite ± garnet-feldspar-quartz paragneiss	Tr	0.02	0.01	Nil	Tr	Nil	NONE
#4 Fig. GS-1-2	Biotite-garnet + cordierite feldspar-quartz paragneiss, pyrite disseminated; granite pegmatite + cordierite + pyrite	Nil	0.02	0.01	Nil	Tr	Nil	NONE
#5 Fig. GS-1-2	Biotite ± garnet ± cordierite-feldspar-quartz paragneiss, pyrite disseminated and in veins; granite, pegmatite and quartz veins ± pyrite	Nil	Tr	0.01	Nil	0.02	0.01	NONE

ii) light grey biotite (5-8%) – garnet + pyrite-feldspar-quartz (25%);

iii) light grey biotite (3-5%) – feldspar-quartz;

iv) dark grey biotite (8-15%) + magnetite-feldspar-quartz (20-25%);

v) grey biotite (8-10%) – garnet-magnetite-feldspar-quartz (25%);

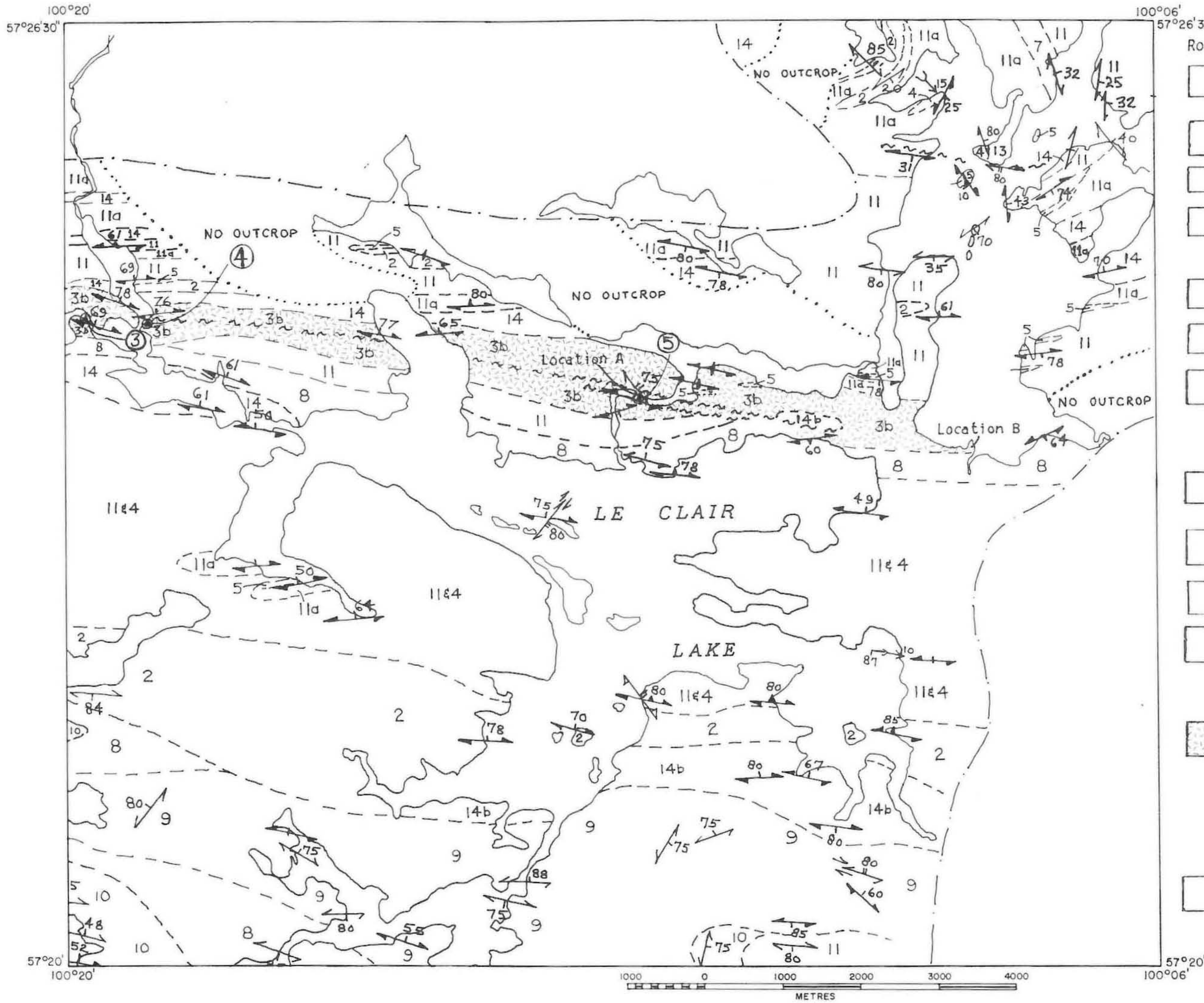
Amphibolite to diorite lenses are less common in this suite of rocks than at Paskwachi Bay.

The presence of sulphide mineralization in the garnetiferous granoblastic rocks and rare biotite-garnet-magnetite-biotite-feldspar-quartz paragneiss suggests a possible genetic link for the two widely separated zones at Paskwachi Bay and Le Clair Lake. The formation of the disseminated sulphides and a pre-metamorphic alteration of the metasediments and metabasic rocks resulted in the specific metamorphic parageneses observed locally in both areas.

A complex of biotite (5%) + magnetite-tonalite to quartz monzonite with inclusions of gneissic diorite, rare layers of biotite (8%) – garnet-gneissic diorite, rare layers of biotite (8%) – garnet-feldspar-quartz granoblastite, and inclusions of thinly interlayered amphibolite and grey fine-to medium-grained biotite (3%) to quartz monzonite to tonalite lie to the north of Le Clair Lake. These rocks have been intruded by a suite of gabbro to diabase dykes. The intrusion of the dykes postdates a period of deformation and metamorphism. These basic dyke are similar to the post D_1 basic to dioritic intrusions at Paskwachi Bay.

A second period of deformation also postdates the intrusion of the basic dykes, similar to the Paskwachi Bay sequence of events. The deformation resulted in shear belts and fault zones and was accompanied by the emplacement of granite pegmatite, monzo-granites and potassium metasomatism. A prominent shear and mylonite belt lies along the zone of mineralization and garnetiferous + cordierite biotite-feldspar quartz granoblastic rocks at the north end of Le Clair Lake. Sillimanite forms fibrolitic sheets within the earlier high grade shear zones whereas other later more brittle zones of deformation are marked by narrow zones of mylonite and ultramylonite. The mylonite and garnetiferous biotite-feldspar-quartz granoblastic rocks are locally silicified and/or cut by carbonate veins and carbonitized. This deformation has also mobilized the originally disseminated sulphides from within the biotite-garnet-cordierite-feldspar-quartz and biotite-garnet- feldspar-quartz granoblastic rocks into sulphide vein networks in zones of silicification. The zone of sulphide mineralization was sampled (Fig. GS-1-2) and the assay results are listed in Table GS-1-1.

Rocks in the southern part of Le Clair Lake and south of Le Clair Lake are dominantly biotite (8-12%) + garnet tonalite and megacrystic biotite (5-10%) granodiorite to tonalite. The biotite + garnet + graphite-feldspar-quartz paragneisses form large and small inclusion zones within these rocks. A gneissic quartz diorite forms small discrete bodies within these rocks. The grey biotite + magnetite tonalite to quartz monzonite forms sills and discrete intrusive bodies which become more extensive in areas further south towards Melvin Lake in the southeast of the project area.



Map units based on Map 1982M.

Rock types:

14b	White monzogranite, medium grained to pegmatitic
14	Monzogranite
13	Metadiabase
11a	Hybrid gneiss of grey biotite-quartz monzonite and gneissic diorite
11	Grey biotite-quartz monzonite ± magnetite
10	Quartz diorite
9	Megacrystic biotite-granodiorite (megacrysts of white feldspar) with inclusions of biotite ± garnet + feldspar + quartz gneiss and biotite-tonalite
8	Biotite-tonalite with inclusions of biotite + garnet + feldspar ± garnet + feldspar + quartz veins
7	Gneissic diorite
5	Amphibolite, massive and layered
4	Grey(5-10%)-feldspar-quartz gneiss ± hornblende ± magnetite with variable amounts of thin amphibolitic layers
3a	Biotite(10-15%) ± cordierite ± sillimanite ± garnet + disseminated pyrite + trace chalcopyrite + feldspar + quartz; biotite + magnetite + garnet + feldspar + quartz at locations A and B
2	Biotite(10-20%) ± garnet ± graphite + feldspar + quartz gneiss
③	Locations of Assays listed in Table GS-1-1

Figure GS-1-2: Outline geology of Le Clair Lake region.

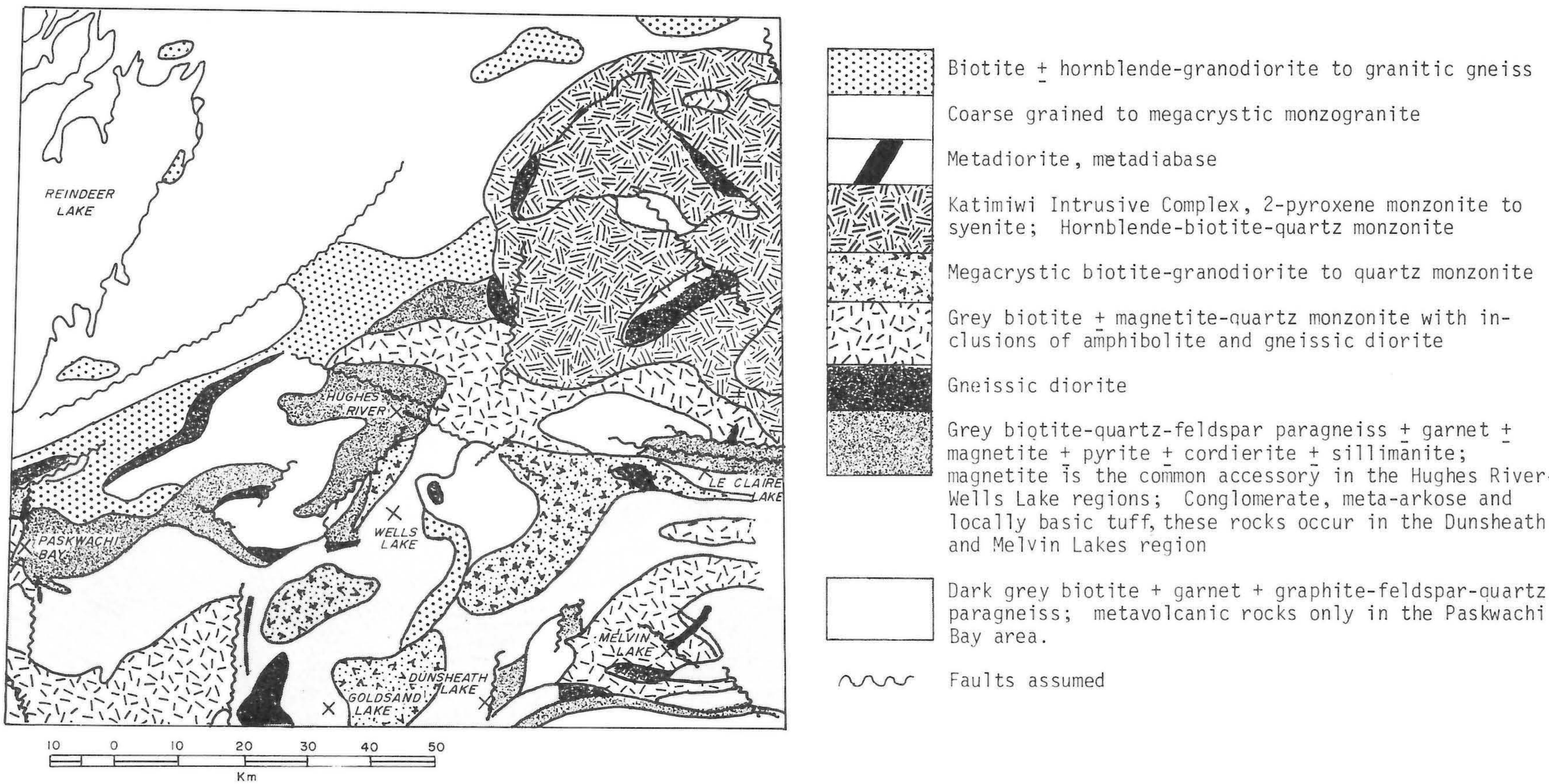


Figure GS-1-3: Lithologic zonation of the Brochet map area (NTS 64F) segment of the Brochet-Big Sand Project and schematic representation of structural relationships.

EYRIE LAKE-HUGHES RIVER-WELLS LAKE-GOLD SAND LAKE

The region between Eyrie Lake and Gold Sand Lake provides the most completely exposed across strike profile in the map area. The lithologic suites as described at Paskwachi Bay and Le Clair Lake, are present as discrete zones along this north-south mapping corridor.

Biotite-cordierite-garnet + sillimanite-feldspar-quartz paragneisses at Eyrie Lake (W.D. McRitchie, 1977) are comparable to the paragneisses of the mineralized zone at the north end of Le Clair Lake. The localized occurrence of garnet-rich pods and anthophyllite + magnetite zones invite comparison with the proposed alteration features observed at Paskwachi Bay and in the mineralized zone at the north end of Le Clair Lake. The region to the west and north of Eyrie Lake is dominantly a granitic gneiss terrain derived from the biotite + magnetite-tonalite with inclusions of gneissic diorite. East of Eyrie Lake the 6 km wide paragneiss belt appears to be faulted against intrusive rocks that are part of the Katamiwi Intrusive Complex.

A 7 km wide belt of foliated biotite + magnetite, quartz monzonite to tonalite, with inclusions of meta-diorite and numerous amphibolite lenses, lies immediately to the south of the Eyrie Lake paragneisses. This zone gives way to a 10 km wide zone of biotite (5-15%) + magnetite-feldspar-quartz (25-30%) granoblastic rock with buff granitic **lit** and irregular zones of gneissic quartz diorite + magnetite. The south margin of this belt is intruded by pink coarse grained to porphyritic monzogranite. The 10 km wide zone of magnetiferous quartzo-feldspathic gneisses and gneissic quartz diorite is apparently truncated to the east against a dome-like structure cored by biotite-magnetite quartz monzonite to granite. However, comparable rocks occur to the east as a 2 km wide zone on Le Clair Lake. The zone does continue to the southwest and its width increases to 20 km. The rocks become increasingly granitized to the west and southwest and the belt is truncated by a broad monzogranite intrusive body lying between Carlson Lake, Preston Lake and Wells Lake. This monzogranite is coarse grained to megacrystic and has a high radiometric signature (total count) making it distinctive for the granitic rocks in the south half of the Brochet map area.

Biotite (8-12%) + garnet-tonalite, with inclusion blocks of biotite + garnet-graphite-feldspar-quartz paragneiss, lies immediately south of the megacrystic monzogranite and the zone of magnetiferous quartzo-feldspathic gneisses and gneissic quartz diorite. The biotite-tonalite and graphitic paragneisses are similar to rocks immediately south of Paskwachi Bay. These rocks are intruded by numerous stocks of megacrystic biotite-granodiorite to tonalite with megacrysts of white plagioclase 1 - 5 cm in size. This megacrystic tonalite is a major component from Gold Sand Lake to Le Clair Lake.

REGIONAL GEOLOGY

In summary an extensive area of graphitic paragneiss heavily intruded by biotite-tonalite occurs in the southern third of the Brochet map area (NTS 64F, Fig. GS-1-3). A zone of altered and mineralized paragneisses forms discontinuous segments across the central part of the Brochet map area from Paskwachi Bay in the west, and east to Le Clair Lake with associated metavolcanic rocks occurring only in the Paskwachi Bay area. Rocks of a dioritic intrusive terrain also extend across the central part of the map area from Paskwachi Bay to north of Le Clair Lake.

A zone of biotite (5-12%) + magnetite-feldspar-quartz (20-30%) granoblastic rocks, of uncertain affinity, form a 20 to 10 km wide zone west and north of Wells Lake and a 2 km zone further to the east of Le Clair Lake. Gneissic quartz diorite lenses are common within these granoblastic rocks. This entire terrain was extensively intruded by the biotite + magnetite-quartz monzonite to tonalite. A period of deformation, metamorphism and emplacement of large bodies of megacrystic biotite-granodiorite to tonalite, was centered in the area between Gold Sand Lake and Le Clair Lakes. A suite of metabasic to gabbroic intrusions (dykes) postdate the first stage of tectonism. A second deformational event postdates the basic dykes and resulted in major shear zones and faulting. This phase of deformation was accompanied by the emplacement of monzogranites and localized potassium metasomatism. This phase of deformation resulted in major discontinuities further disrupting the already highly intruded terrain.

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1977: Reindeer Lake-Southern Indian Lake, Regional Correlation; Manitoba Mineral Resources Division Report of Field Activities, pp. 13-18.

1977: Brochet Regional Compilation; Manitoba Mineral Resources Division, Preliminary Map 1977M-1.

GS-2 RAT RIVER CHANNEL AREA

(Part of 64B/6)

by H.V. Zwanzig

INTRODUCTION

Several helicopter-supported traverses were conducted across the best exposures in an 85 km^2 area east of the Rat River Channel during a brief visit to the area by the author, A.H. Bailes, E.C. Syme and their assistants (Fig. GS-2-1). Outcrops were also examined along the road to South Bay (Southern Indian Lake) and along the Issett Channel.

The purpose of the work was to update the existing geological coverage of the metavolcanic and metasedimentary rocks, outline the local limits of the greenstones and examine their structural relationship to the surrounding intrusive rocks and gneisses.

GENERAL GEOLOGY

Five easterly trending lithologic belts traverse the Rat River-Issett Channel. They are from north to south:

(1) the Southern Indian Gneiss Belt;
(2) a wedge-shaped intrusive belt of tonalite and granodiorite;
(3) a metavolcanic and metasedimentary belt which is the eastern extension of the Wasekwan Group within the Rusty Lake Greenstone Belt;
(4) a diorite belt;
(5) the Livingston Plutonic Belt, comprising granodiorite and granite.

Shear zones occur on the south margins of the Southern Indian Belt and the south margin of the metavolcanic rocks.

Directly east of the Rat River Channel the outcrop belt of metavolcanic and metasedimentary rocks is 4 to 5 km wide. The belt strikes east-northeast and has been traced for 15 km east of the channel by McRitchie (1981); Corkery and Lenton (1980); and Lenton and Corkery (1981). The present work indicates that the belt consists of a north-facing Wasekwan succession which is sheared at the margins and probably fault-bounded. The succession contains narrow units of metabasalt, felsic tuff and minor breccia, overlain by thicker units of metasedimentary rocks and amphibolite. Similar units have been mapped along strike, west of the channel (Baldwin, 1980). The Wasekwan Group rocks are intruded by shallow-level mafic to intermediate plutons and by granodiorite.

South of the supracrustal belt there is a mafic to felsic intrusive complex which forms a 4 km wide margin on the granodiorite of the Livingston Plutonic Belt. The complex contains multiple intrusions of diorite cut by numerous small bodies of granodiorite, tonalite and granite. The felsic rocks form a stockwork of veins and dykes throughout much of the complex. Locally, diorite rafts and granodiorite matrix form an agmatite. The diorite is fine grained, locally porphyritic and looks similar to a suite of shallow-level intrusions which occurs in the main part of the Rusty Lake Belt (Baldwin, 1980). Smaller bodies of diorite intrude the Wasekwan Group rocks to the north. The Livingston granodiorite cuts the diorite complex along a sharp intrusive contact in the south.

A wedge-shaped area of granitic intrusive rocks separates the Wasekwan Group from the Southern Indian greywacke-gneiss belt to the north (McRitchie, 1981). Intrusions comprise foliated tonalite, granodiorite and granite. An east-trending zone of sheared felsic gneiss, metagreywacke, amphibolite and pegmatite (Issett shear zone) defines the southern boundary of the Southern Indian Gneiss Belt.

STRUCTURE

Near the Rat River Channel the Wasekwan Group dips steeply to the north and northeast. Graded bedding and pillow tops indicate that the volcanic succession faces northeast. (See also Baldwin, 1980). The overlying, predominantly sedimentary succession is strongly foliated and no facing directions were recorded there. Volcanic units which strike 035° are cut by foliation striking 025° - 030° and appear to be truncated along a fault by diorite to the south (Fig. GS-2-2).

A younger foliation in the major granitic terrains trends west and northwest parallel to the **lit-par-lit** layering in the Southern Indian metagreywacke. In the diorite belt a fine northeast-trending schistosity is crosscut by a northwest-trending spaced foliation.

The contact zone between the Wasekwan Group rocks and the Southern Indian Gneiss at the Issett Channel is interpreted to be a fault. The associated shear zone trends west to northwest and may be up to I km wide. Units involved in the deformation are metagreywacke, amphibolite, tonalite, pegmatite and magnetiferous felsic rock which is interpreted to be sheared orthogneiss. A similar zone is exposed along strike 25 km to the west on Opachuanau Lake (Zwanzig, 1974 and unpubl. data). The Opachuanau-Issett zone is here interpreted to be the eastern extension of the Johnson shear (Cartwright Lake fault zone) from the Lynn Lake Greenstone Belt (Gilbert et al., 1980). Granitic intrusions occur between the segments of the shear zone. The sheared rocks and the adjacent foliated tonalite were mapped as Opachuanau Gneiss by Steeves and Lamb (1972). They are here interpreted as part of the Southern Indian Gneiss, possible Wasekwan Group amphibolite and pre-Sickle tonalite (Zwanzig, 1974, p. 16). The supracrustal rocks on the margin of the Southern Indian Belt constitute mainly greywacke-migmatite but arkosic gneiss was also mapped by Steeves and Lamb (1972) and McRitchie (1981).

The shear zone is exposed in clay pits along the road l4 km southwest of South Bay. Homogeneous and banded felsic gneiss with rounded quartz and feldspar eyes and rare potassium feldspar porphyroclasts have a mylonitic origin. The protolith was probably tonalite which had been locally injected by pegmatite. Carbonate veins, folded tectonic breccia and a narrow gossan zone mark a discrete fault east of the road. The foliation and early folds trend 260° to 315°. Z-shaped kink folds in the foliation trend northeast. Rootless and intrafolial folds indicate an apparent right lateral displacement in the shear zone.

WASEKWAN GROUP

BASALT

About 100 m of aphyric metabasalt is exposed on a single ridge near the base of the volcanic succession. The dark green to black basalt is generally pillowed and weakly amygdaloidal. A unit of banded iron formation 10 m wide separates two flows.

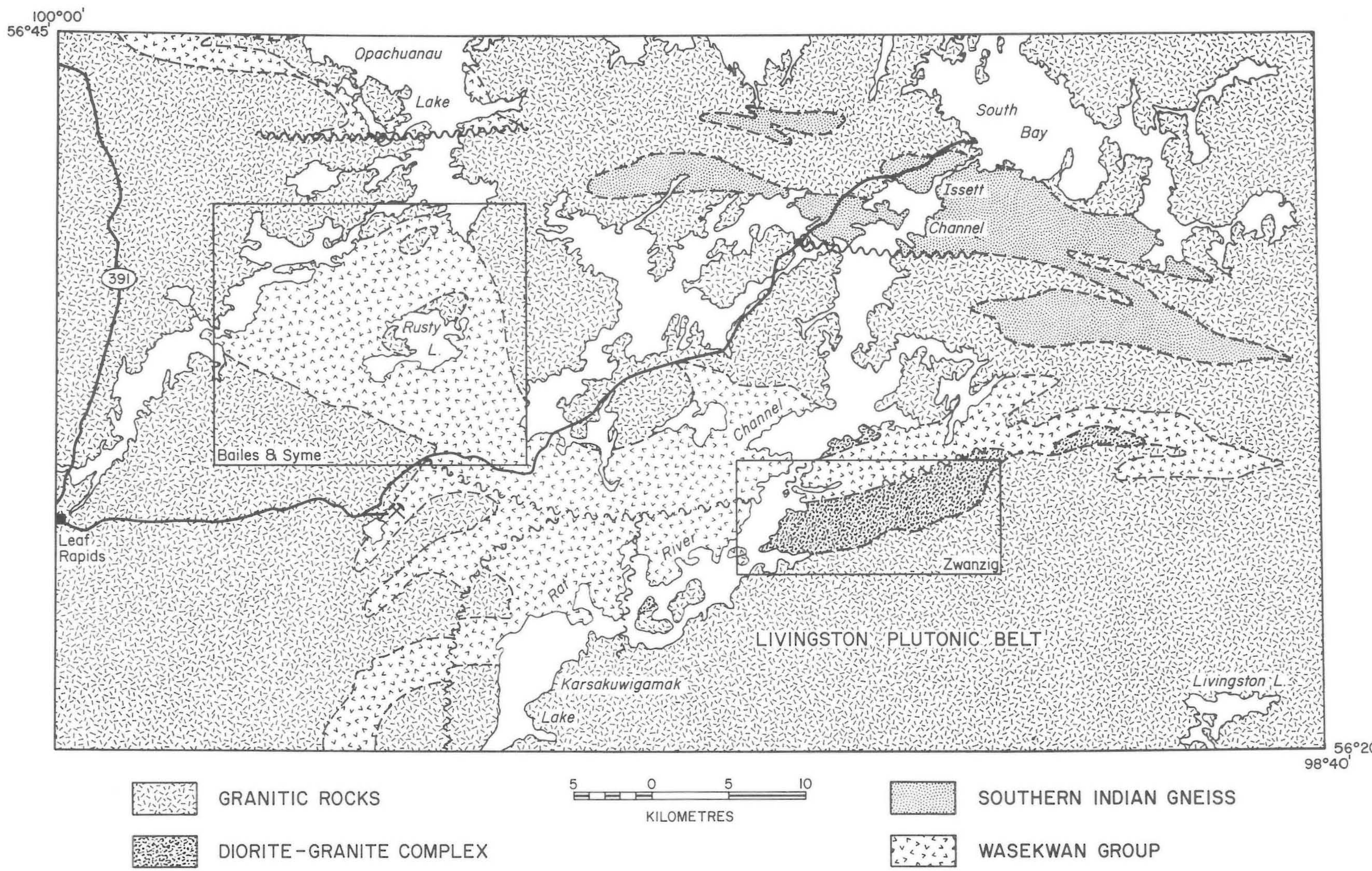
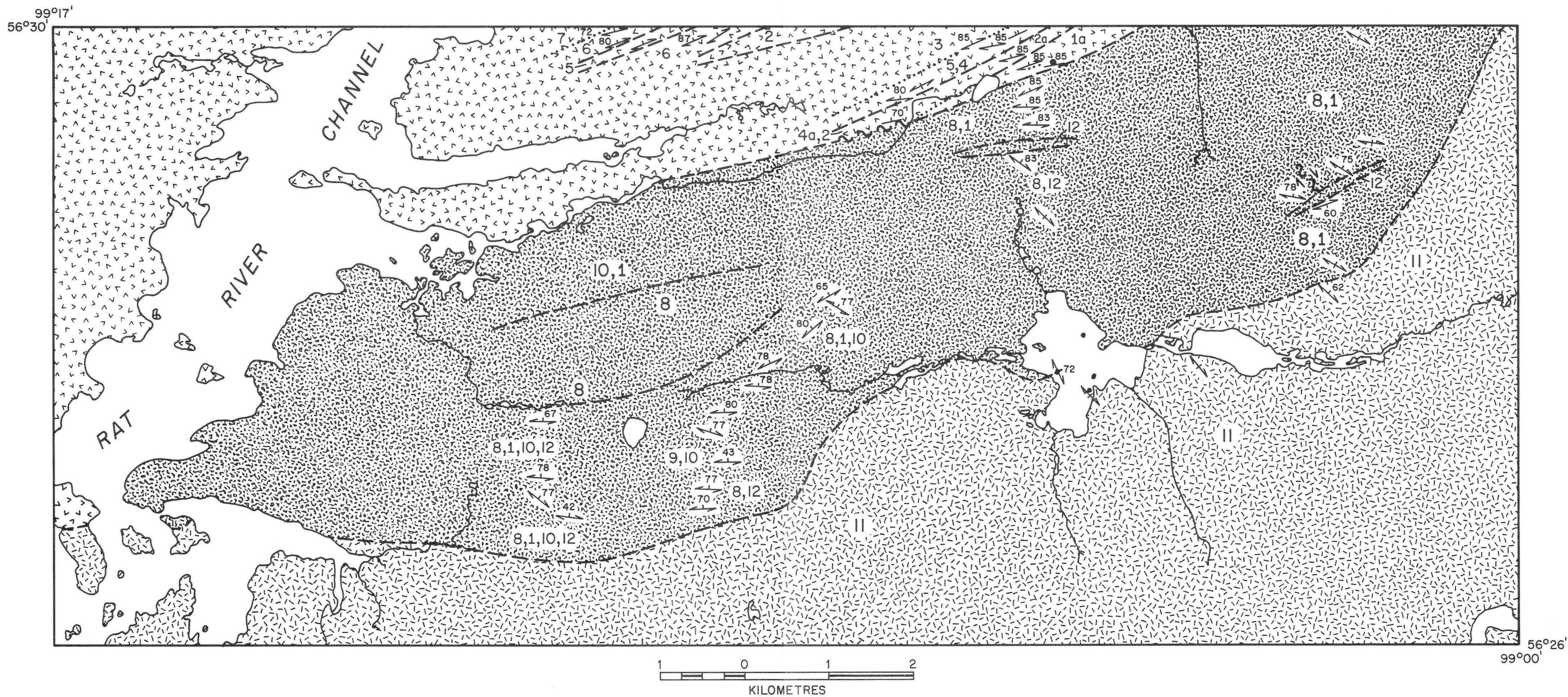


Figure GS-2-1: Outline geology of the Rusty Lake Greenstone Belt and location of 1:50 000 scale map areas (Zwanzig, this report; Bailes & Syme, Report GS-3).



LEGEND

APHEBIAN

12 Biotite granite, aplite, leucogranite, pegmatite

Livingston Pluton Belt

11 Hornblende-biotite granodiorite

Diorite Complex

10 Quartz diorite, tonalite

9 Gabbro, diabase, amphibolite

8 Diorite, quartz diorite

Wasekwan Group

7 Quartz-sericite schist, phyllite, mudstone

6 Quartz-hornblende schist, metagreywacke

5 Layered amphibolite, mafic mudstone

4 Conglomerate, mudstone, 4a rhyolite pebble conglomerate

3 Plagioclase amphibolite, intermediate volcanic rocks

2 Felsic volcanic rocks, 2a tuff, 2b breccia

1 Fine grained amphibolite, metabasalt, 1a pillow basalt

SYMBOLS

Bedding, tops known; tops unknown

Foliation, inclined; vertical

Fracture cleavage

Pillow tops

Shear zone

Geological contact approximate; assumed

Figure GS-2-2: Outline geology of the Rat River Channel area.

AMPHIBOLITE

Fine grained amphibolite occurs as local screens in diorite and as small isolated outcrops in the metasedimentary rocks. Local amygdales suggest an extrusive origin for some of the amphibolite.

FELSIC METAVOLCANIC ROCKS

A 30 m thick sequence of layered felsic rocks interpreted as rhyolitic tuff overlies the basalt. Variations in shades of light grey to white and brown define massive 30 cm layers. The unit is interbedded with conglomerate in the west and with basalt in the eastern part of a local outcrop area (Fig. GS-2-2). Uniform, pale brown weathering layers with prominent calc-silicate veins and lenses may be tuff or mudstone.

A small deposit of 2-5 m layers of pyroclastic breccia contains rhyolite blocks up to 1 m long. The blocks contain 20% plagioclase phenocrysts 2 mm long; the felsic matrix has a higher proportion of phenocrysts.

METASEDIMENTARY ROCKS

The pyroclastic rocks are overlain by and interbedded with conglomerate, greywacke and mudstone exposed in a 500 m section. Close to the Rat River Channel an additional 1000 m of metasedimentary rocks are exposed.

Conglomerate

The lower conglomerate beds contain abundant angular rhyolite pebbles and granules, and locally mafic pebbles in a matrix of intermediate greywacke or mafic mudstone. They are interlayered with fine grained metasedimentary rock and overlain by oligomictic volcanic conglomerate and by an intermediate volcanic unit. Conglomerate beds are 1-100 cm thick; some have normal size-grading and one observed bed has reverse abundance-grading of rhyolite clasts. Many beds are matrix-supported or contain only scattered pebbles.

The upper conglomerate beds contain feldspar-porphyry pebbles and cobbles. The thickest bed (150 cm) has abundant intraformational black shale and greywacke clasts.

Fine Grained Metasedimentary Rocks

The epiclastic rocks which overlie the tuff are mafic mudstones with prominent amphibole blastesis. Layers are 3 mm - 10 cm thick.

The upper sedimentary succession contains largely thin-bedded intermediate (light to dark grey) and mafic (light to dark green) wacke and mudstone. Hornblende-rich calc-silicate veins and lenses are common in the south. The overlying rocks comprise mafic and felsic mudstone with local silicate iron formation (black amphibolite). Very thin-bedded quartz-sericite schist and graphitic to pyritic phyllite occur in the north.

INTRUSIVE ROCKS

DIORITE COMPLEX

The intrusive rocks exposed south of the Wasekwan Group outcrop belt forms a complex of small diorite bodies with screens of amphibolite and abundant granitoid veins and dykes. The diorite is composed of amphibole (40 - 60%), plagioclase, magnetite and local pyrite. The grain size and phenocryst content is variable but fine grained diorite is most common. Porphyritic phases contain 1-2 mm grains of hornblende and/or plagioclase. The coarser varieties have up to 7 mm long hornblende grains after pyroxene phenocrysts.

The diorite is intruded by medium grained quartz diorite with 10-20% quartz and 30-45% hornblende. Younger, narrower dykes contain buff, medium grained biotite-granodiorite, pink magnetiferous aplite and leucogranite. These rocks are cut by fine grained (0.5 mm) white tonalite and pegmatite. The more felsic rocks were probably emplaced with the granodiorite to the south and they are less foliated than the intermediate intrusions.

GRANODIORITE

The northern margin of the Livingston Plutonic Belt is a grey to pink weathering, coarse grained, homogeneous granodiorite. This rock contains 8 mm quartz eyes (25%) and 2 mm amphibole needles (10-15%) or small amphibole-biotite aggregates where the rock is strongly foliated.

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GS-3 RUSTY LAKE AREA

(parts of 64B/12)

by A.H. Bailes and E.C. Syme

INTRODUCTION

A ten-day program was conducted to upgrade existing mapping of volcanic and sedimentary rocks in the Rusty Lake area (Fig. GS-2-1). The initial objective was to re-map these rocks at 1:20 000 scale but a combination of heavy moss and lichen growth on outcrops, almandine-amphibolite facies metamorphism, pervasive calc-silicate alteration and widely-spaced outcrops precluded detailed mapping at this scale. Instead, the existing 1:50 000 scale map (Steeves and Lamb, 1972) has been extensively modified (Fig. GS-3-1) to incorporate the geology observed on a series of check traverses. The major findings are:

(1) The stratigraphy of the supracrustal rocks is similar to that to the southeast of Rusty Lake in the Northern Block of Baldwin (1982).
(2) Metasedimentary rocks with a volcanic provenance are the dominant rock type in the Rusty Lake area.
(3) Rocks previously mapped by Steeves and Lamb (1972) as mafic flows are a complex of gabbroic sills (unit 10).
(4) Sulphide-rich formations (unit 9) northeast of Rusty Lake are likely equivalent to sulphide formations identified by Baldwin (1982) in his Northern Block.

Major folds occur within the Rusty Lake belt but the precise geometry of the folds cannot be accurately defined due to low outcrop density and difficulties in identifying stratigraphic units. The folds shown on Figure GS-3-1 are an interpretation which is consistent with most of the observed structural and stratigraphic data.

The supracrustal rocks have been subjected to at least lower almandine-amphibolite facies regional metamorphism, as indicated by granoblastic recrystallization and local coarse amphibole blastesis. Most primary textures and structures, including bedding, have been obliterated by recrystallization and deformation. A pervasive, pre-metamorphic regional calc-silicate alteration has effected all the pre-Sickle Group rocks, with the exception of the "Opachuanau gneiss". This alteration varies from minor amphibole blastesis adjacent to amphibole, epidote, or quartz-filled fractures to complete alteration of some sedimentary rocks to amphibole, epidote and quartz. The alteration is strongest north and west of Rusty Lake and commonly completely obscures primary lithologies.

DESCRIPTION OF SUPRACRUSTAL ROCKS[1]

Conglomerate, sandstone and siltstone (unit 2)

These metasedimentary rocks are fine grained, granoblastic, recrystallized and composed of quartz + feldspar + amphibole or quartz + feldspar + biotite. Garnet occurs locally adjacent to the granodiorite pluton (unit 16). Bedding is rarely preserved. A single graded bed south of Rusty Lake indicates stratigraphic tops are to the north. Rare conglomerate beds contain strongly flattened aphyric and porphyritic mafic and felsic volcanic clasts. The sediments vary widely in mafic content and in the ratio of quartz to feldspar.

[1]Descriptions are given only for those rocks examined during this program.

Felsic tuff (unit 5)

Light pink, grey and white felsic tuff occurs south of Rusty Lake, in a unit 300 m thick. Variable colour, texture, and quartz and feldspar phenocryst content in this unit suggests that it is a bedded tuff, although layer contacts were not observed. Layers or laminae defined by concentrations of acicular amphiboles occur in most varieties of the tuff.

Aphyric pillowed basalt (unit 7)

This areally restricted pillowed basalt is the only volcanic flow unit observed between Rusty Lake and the Churchill River. The thickness of this unit is unknown as it probably occurs in a fold hinge. The basalt weathers dark green and on fresh surfaces is dark grey to dark green. It is aphyric, fine grained, well foliated and composed of amphibole + feldspar + epidote, with minor biotite along foliation planes. Pillow selvages are dark green, amphibole-rich and up to 5 mm thick. Pillows are oval, 20 to 100 cm in maximum dimension, and flattened in the plane of schistosity. The pillows, which are predominantly non-vesicular, locally contain dark grey chert in interpillow spaces. Intense schistosity has locally obliterated primary pillow structures.

Sandstone and conglomerate (unit 6)

The sandstone weathers buff to pale green and is white to buff or green on fresh surfaces. It is composed of feldspar, epidote, quartz, amphibole, carbonate and local magnetite; grain size is 0.5 to 1 mm. In the few exposures where layering is observed it is defined by variation in calc-silicate mineralogy; beds are 5 to 30 cm thick. A regional calc-silicate alteration has strongly overprinted most of this unit.

The conglomerates weather light grey and are light to medium grey on fresh surface. They are strongly foliated and contain lens-shaped clasts with flattening ratios of 1:15 to 1:30 on horizontal surfaces. Pebble- to cobble-sized clasts include: 1) white fine grained felsic volcanics; 2) white porphyritic felsic volcanics; 3) dark green aphyric mafic volcanics; and 4) light to medium grey, 1-2 mm, equigranular granitoid rocks containing 10-15% amphibole and 20% quartz. The matrix consists of grains and granules of these clast lithologies but is more commonly recrystallized to fine grained quartz + feldspar + biotite + amphibole. The conglomerate is interlayered on a scale of 20 cm to several metres with fine to coarse metasandstone or greywacke.

Greywacke, lithic arenite, minor conglomerate (unit 8)

The greywacke and lithic arenite are fine grained, granoblastic, recrystallized rocks composed of quartz + feldspar + biotite + muscovite or quartz + feldspar + amphibole + biotite. They are similar to the metasedimentary rocks of unit 2 but differ in that: 1) they are slightly more siliceous; 2) they contain rare conglomerate beds with plutonic clasts; and 3) they are associated with sulphide-bearing quartzites (unit 9) northeast of Rusty Lake. Similar greywackes are associated with sulphide-bearing siliceous sediments in the area southeast of Rusty Lake (Baldwin, I982).

Pebble and cobble conglomerates occur in this unit northwest of Rusty Lake. The pebbles, which are tectonically flattened in a ratio of 5:1 within the schistosity, comprise mainly buff to white weathering felsic clasts of uncertain origin. They also include a wide variety of intrusive clasts, including hornblende tonalite,

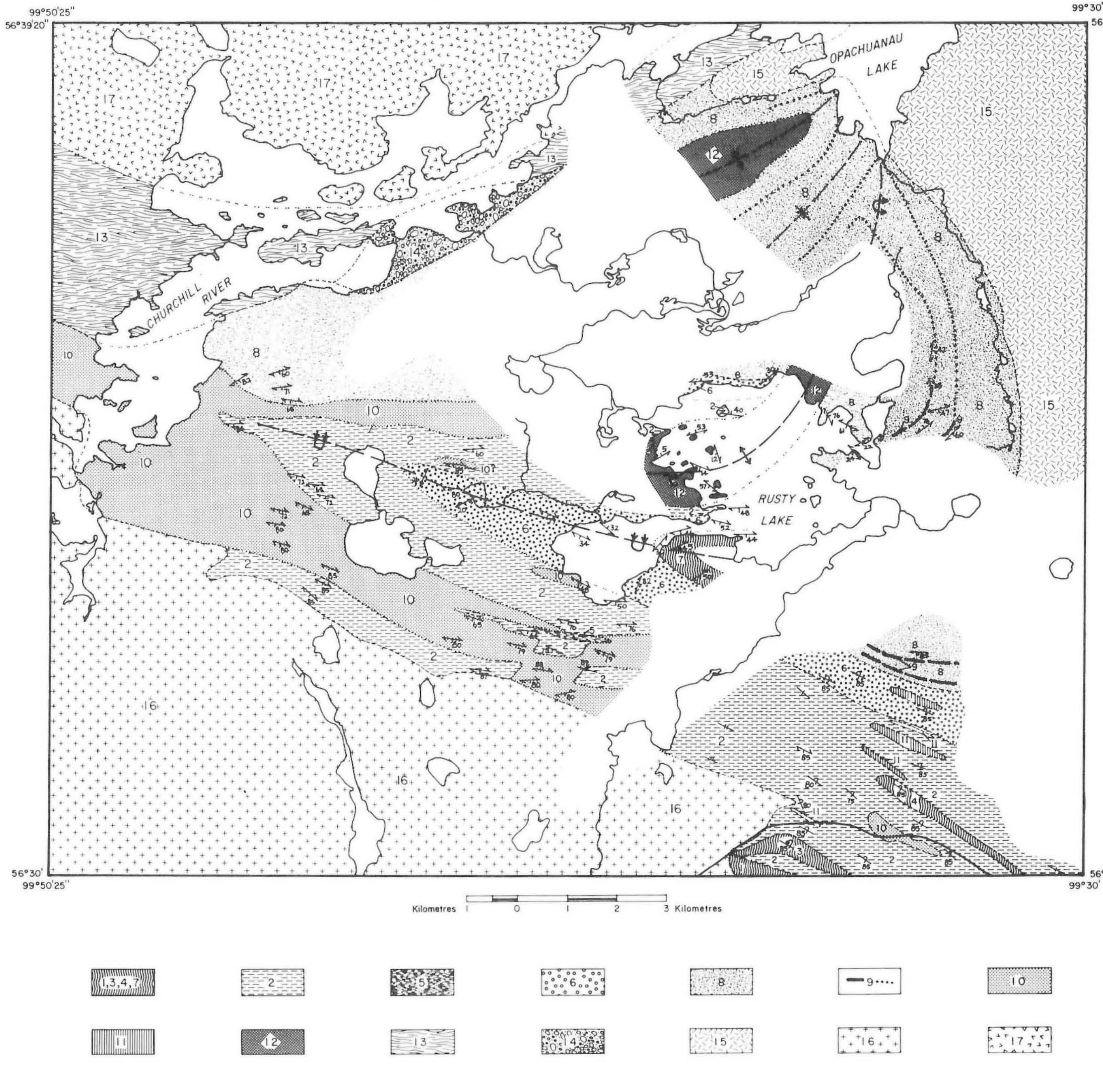

Figure GS-3-1: *Simplified geological map of the Rusty Lake area, modified from Steeves and Lamb (1972). Data in the southeast part of the area is from Baldwin (1982). Legend: 1) basalt; 2) volcanic-derived conglomerate, sandstone and siltstone with an intermediate to mafic composition; 3) plagioclase-phyric basalt; 4) aphyric basalt; 5) felsic tuff; 6) volcanic- and plutonic-derived sandstone and interbedded conglomerate; 7) aphyric pillowed basalt; 8) greywacke, lithic arenite, minor conglomerate with volcanic and plutonic clasts; 9) quartzite with disseminated pyrrhotite and pyrite, massive pyrrhotite; 10) mafic sill complex composed of porphyritic and aphyric gabbro and diorite; 11) diorite, quartz diorite; 12) hornblende-phyric tonalite; 13) "Opachuanau gneiss" (foliated tonalite); 14) Sickle Group polymictic conglomerate; 15) biotite-hornblende tonalite and diorite; 16) biotite-hornblende granodiorite; 17) pink "quartz-eye" granite and quartz monzonite.*

pyroxene-phyric gabbro, diorite and aplitic granite. The matrix is typically hornblende- and epidote-rich.

Quartzite with disseminated pyrrhotite and pyrite (unit 9)

Two units of sulphide-bearing quartzite accompanied by rusty weathering siliceous sedimentary rocks and narrow massive sulphide zones occur northeast of Rusty Lake. The quartzites contain 5 to 35 per cent pyrrhotite and minor pyrite, and locally host massive pyrrhotite zones a few metres in width. Several exploration pits were observed across the massive sulphide zones. Similar sulphide-bearing siliceous sediments, including banded cherts, are documented by Baldwin (1982) in the area southeast of Rusty Lake. These zones are not silicified and mineralized shears as reported by Steeves and Lamb (1972), but rather are true metasedimentary formations.

Mafic sill complex (unit 10)

Porphyritic and rare aphyric gabbro and diorite form a complex of large sills within unit 2, south of Rusty Lake and west to the Churchill River (Fig. GS-3-1). The intrusive rocks are dark green on weathered and fresh surfaces. Amphibole pseudomorphs after pyroxene phenocrysts are 0.5 - 10 mm in diameter and vary in abundance from 5 to 50 per cent; plagioclase phenocrysts are generally 0.5 - 2 mm and comprise up to 20 per cent. Phenocrysts vary in size and abundance within single bodies or between different sills. The groundmass is typically a fine grained (0.25 - 1 mm) mosaic of feldspar and amphibole that commonly displays a moderate to strong schistosity. Stringers, veins and pods of epidote + amphibole + carbonate crosscut the gabbros and locally destroy primary textures. The intrusions were previously mapped as porphyritic and aphyric flows (Steeves and Lamb, 1972) but their intrusive nature is indicated by the occurrence of large metasedimentary screens within the complex, identical dykes of porphyritic gabbro outside the main intrusive complex, chilled contacts against metasedimentary rocks, and the complete absence of flow structures.

Hornblende-phyric tonalite (unit 12)

Foliated hornblende-phyric tonalite plugs occupy the cores of two doubly-plunging anticlines (Fig. GS-3-1). The tonalite weathers white and is white to pale grey on fresh surface. It is composed of 15 - 25 per cent 1-4 mm hornblende phenocrysts (partly altered to biotite), 30-35 per cent 1 mm quartz and 45 - 50 per cent 1 mm plagioclase. The tonalite is strongly foliated and contains local epidote-filled fractures. It is cut by post-foliation dykes of pink aplite.

"Opachuanau gneiss" (unit 13)

Spot checks of the Opachuanau gneiss (unit 10a, Steeves and Lamb, 1972) on the Churchill River indicate it to be a foliated hornblende-biotite tonalite. Zwanzig (pers. comm.) has observed an unconformable contact between this tonalite and the overlying Sickle Group conglomerate on a now-flooded exposure on the Churchill River.

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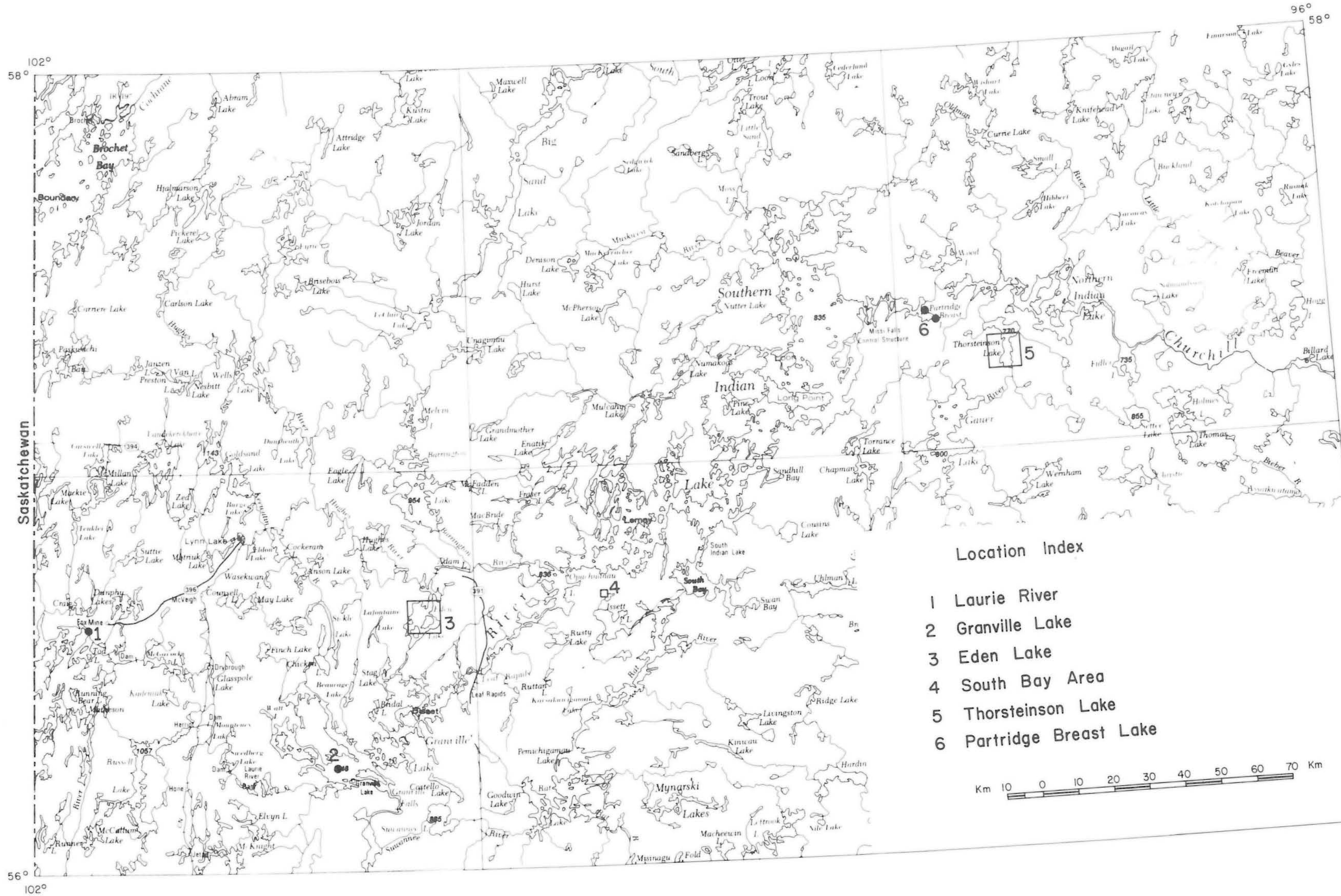

Figure GS-4-1: Index map to localities examined.

GS-4 GRANITE-PEGMATITE STUDIES, LYNN LAKE REGION

by P.G. Lenton

INTRODUCTION

As part of an ongoing program of evaluating granitic pegmatites and source granites in the province, six locations in the Lynn Lake and Southern Indian Lake areas were examined. All represent occurrences of pegmatites previously reported but not examined in detail. Locations are shown in Figure GS-4-1.

Individual pegmatites were examined in detail and, where possible, the attitude and relationship to country rock was determined. Samples of primary muscovite and microcline were obtained from various locations in the pegmatites. They will be analyzed for rare alkali elements to evaluate the bodies by the method of Gordiyenko (1971).

LAURIE RIVER

Gilbert et al. (1980) reported a large complex body of pegmatite on the Laurie River between Tod and Laurie Lakes. The body lies within metasedimentary rocks of predominantly greywacke composition (Fig. GS-4-2). Three occurrences were examined: an irregularly-shaped 200 m by 450 m pegmatitic granite on the south shore of the river; a similar body of 120 m by 35 m exposure area on the north shore; and a series of discrete dykes flanking the larger body. The attitude of all bodies is near vertical with a northwest trend. Inclusions of country rock are common near the contacts. Rafts of country rock upto 35 m by 115 m occur in the core of the largest body.

The two bodies of pegmatitic granite comprise five main textural phases:

1. coarse leucocratic muscovite granite
2. coarse miarolitic granite
3. graphic granite
4. layered aplite
5. potassic pegmatite

The distribution of these phases, as shown in the cross-section of Figure GS-4-2, is highly asymmetric, almost random in nature, although potassic pegmatite is most common in the east and leucogranite in the west.

The leucocratic granite is a coarse (4 to 6 mm) red haplogranite with approximately 1 per cent muscovite and traces of tourmaline. Grain size and texture are uniform except in one area on the west side of the largest body where it becomes seriate porphyritic with a 4 mm to 15 mm grain size range. The miarolitic granite is the same textural rock as the coarse leucocratic granite with the addition of numerous oval to irregular pods of zoned pegmatite upto 1 m in diameter. The pods have a rim of coarse microcline with subordinate plagioclase and quartz cores containing large, blocky, in places graphic, microclines. Coarse books of muscovite and tourmaline crystals are common along the edge of the quartz core.

The graphic granite is a very coarse (1 cm) red quartz-rich granite containing upto 50 per cent of 10 to 60 cm graphic microcline megacrysts. Muscovite in the matrix can reach 5 per cent. Tourmaline is a common accessory mineral.

Layered aplite is most common as convolute veins in the graphic granite and along the margins of the potassic pegmatite. It is a fine grained granite in which albitic plagioclase is more abundant than microcline. Quartz contents are lower than in the coarser granites. The layered appearance is imparted by thin seams of muscovite-quartz + tourmaline or thin microcline pegmatites (see Fig. GS-4-3). Garnet is a minor accessory mineral.

The potassic pegmatite comprises blocky microcline crystals (dominantly non-graphic) in a quartz-muscovite-tourmaline + garnet matrix with very little visible plagioclase. Irregular bodies of graphic granite occur within the massive pegmatite. Several small inclusions of country rock with thin tourmalinized rinds occur in the massive pegmatite.

A series of parallel 1 to 3 m thick pegmatite dykes exposed along the river west of the largest pegmatitic granite were examined. They were probably derived from the pegmatitic granite. The dykes are mineralogically simple, symmetrically zoned bodies with the same steep dip and northwest trend as the granites. Typically the dykes comprise microcline-rich intermediate zones flanking a massive quartz core. Coarse muscovite, blocky microcline and tourmaline crystals are concentrated along the quartz core margins. The centres of the quartz bodies are commonly rose quartz. An exceptional occurrence is a 30 cm dyke 100 m west of the main granite that comprises a fine grained aplitic(?) rock permeated with open cavities lined with euhedral quartz crystals that are completely coated in fine grained crystals of low albite.

GRANVILLE LAKE

Cranstone (1968) reported an occurrence of beryl in a 5 m wide dyke on an island in southern Granville Lake. The beryl crystals, described as greenish 5 by 15 cm euhedral crystals, occurred with apatite, tourmaline and greenish yellow mica in the quartz core zone of the dyke. Cameron (1981) attempted to locate the occurrence described by Cranstone. Cameron was not able to locate the showing because of high water conditions but was able to locate a smaller showing. Neither showing was located this year. Northwest of the original showing a large dyke of pegmatite exposed along the north shore of an island and striking parallel to Cranstone's showing was examined in detail. It comprises a complex dyke of pegmatitic granite and pegmatite striking 154° dipping 22° south.

The hanging wall contact is a zone of numerous country rock inclusions in a red haplogranite. Pegmatitic material is rare, occurring as scattered pods of microcline-quartz-muscovite pegmatite (unzoned) and a few veins of coarse pegmatite. There is a gradual transition away from the hangingwall into a coarse red muscovite-biotite granite with 10 to 50 cm graphic microcline megacrysts and parallel vein systems of very coarse pegmatitic material. The lowest section of the dyke exposed comprises a red pegmatitic granite (very coarse granite with numerous quartz segregations and large (upto 1 m) blocky microclines) associated with numerous convolute veins of fine grained layered granite. Layering is defined by concentrations of muscovite and garnet and thin seams of potassic pegmatite. Biotite becomes as abundant as muscovite in the pegmatitic granite.

The mineralogy of the granite-pegmatite complex is constant throughout. The granite comprises microcline, quartz, plagioclase, muscovite, biotite, and traces of garnet and magnetite. The pegmatite is coarse to giant microcline (both graphic and non-graphic), quartz, muscovite, biotite, garnet, tourmaline and magnetite. No beryl was identified. Minor shearing parallel to the contacts is common throughout the body with attendant sericite-chlorite-epidote alterations.

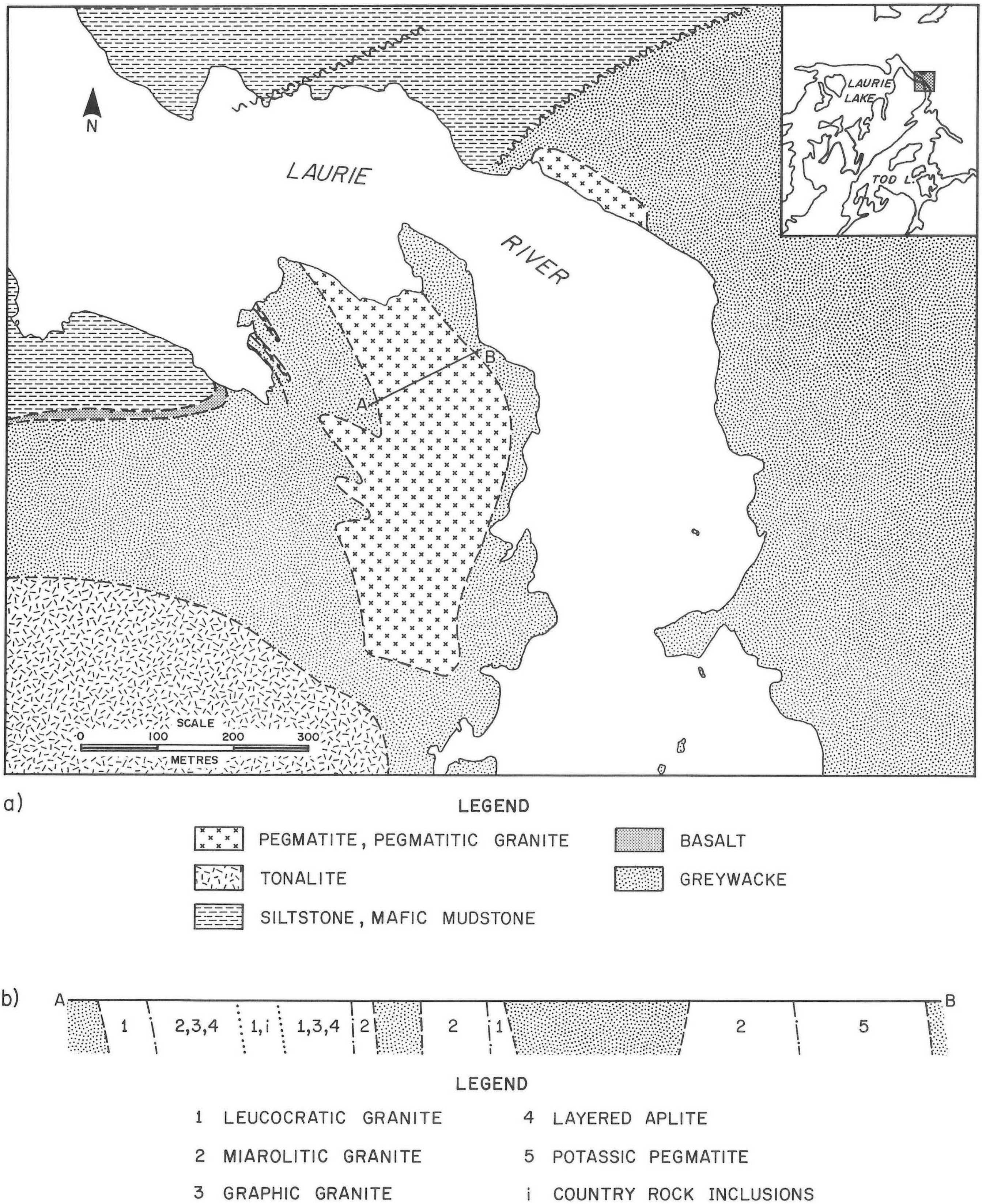

Figure GS-4-2: Generalized geological setting of the Laurie River occurrence: (a) with a schematic cross-section, (b) along the section A-B. Note the asymmetric unzoned character of the body.

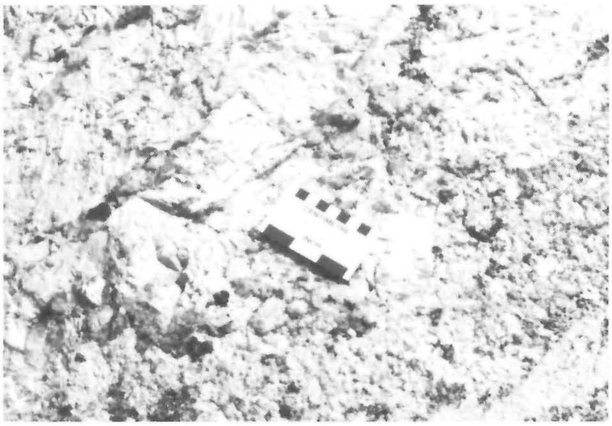

Figure GS-4-3:

Layers of laminated aplite in the graphic granite phase of the Laurie River pegmatitic granite.

Several smaller dykes on the surrounding islands and north on the shore of the lake were examined. They were all found to be simple unzoned microcline-quartz-muscovite + biotite + tourmaline dykes.

SOUTH BAY AREA

Several large bodies of pegmatite were reported by Steeves and Lamb (1971) in a belt extending west from South Bay, north of Issett Lake to Opachuanau Lake. The largest of these bodies, an area approximately 2 by 10 km northwest of Issett Lake, was examined. It comprises an extensive area of high grade migmatites derived from garnetiferous greywacke gneiss. The pegmatite represents coarse to pegmatitic segregations of granodiorite mobilizate. The pegmatitic mobilizate comprises microcline, oligoclase, quartz and biotite with traces of garnet, cordierite and apatite.

EDEN LAKE

Cameron (1978) reported large bodies of pegmatite in a complex intrusive terrain centered on Eden Lake. Several of these bodies were examined. They are dominantly two feldspar-quartz-biotite pegmatites with no peraluminous minerals developed. They appear to be associated with a pink foliated leucogranodiorite which is one of the youngest intrusive bodies in the area. In the southwest part of Eden Lake there are several small exposures of graphic granite which is composed of 95 per cent graphic microcline blocks upto 1 m in width and 5 per cent dark grey interstitial quartz. Micas are absent.

THORSTEINSON LAKE

In the course of regional mapping, McRitchie (1978) and Corkery and Lenton (1979) examined a body of red quartz-rich leucocratic granite centered on Thorsteinson Lake. Samples of the Thorsteinson granite yielded a Rb/Sr isochron age of 1710 $\pm$ 20 Ma, initial ratio = 0.7046 $\pm$ 0.0012 (Clark, 1981). During the isotopic studies Clark determined that the granite exhibits extreme Sr depletion. Subsequent analysis and field examination has shown this body to be a well differentiated granitic plug comprising four textural phases:

1. marginal hybrid monzogranite;
2. medium to coarse grained seriate porphyritic leucocratic granite;
3. miarolitic granite;
4. pegmatitic granite.

These textural phases (Fig. GS-4-4) can be related to increasing chemical differentiation (Fig. GS-4-5).

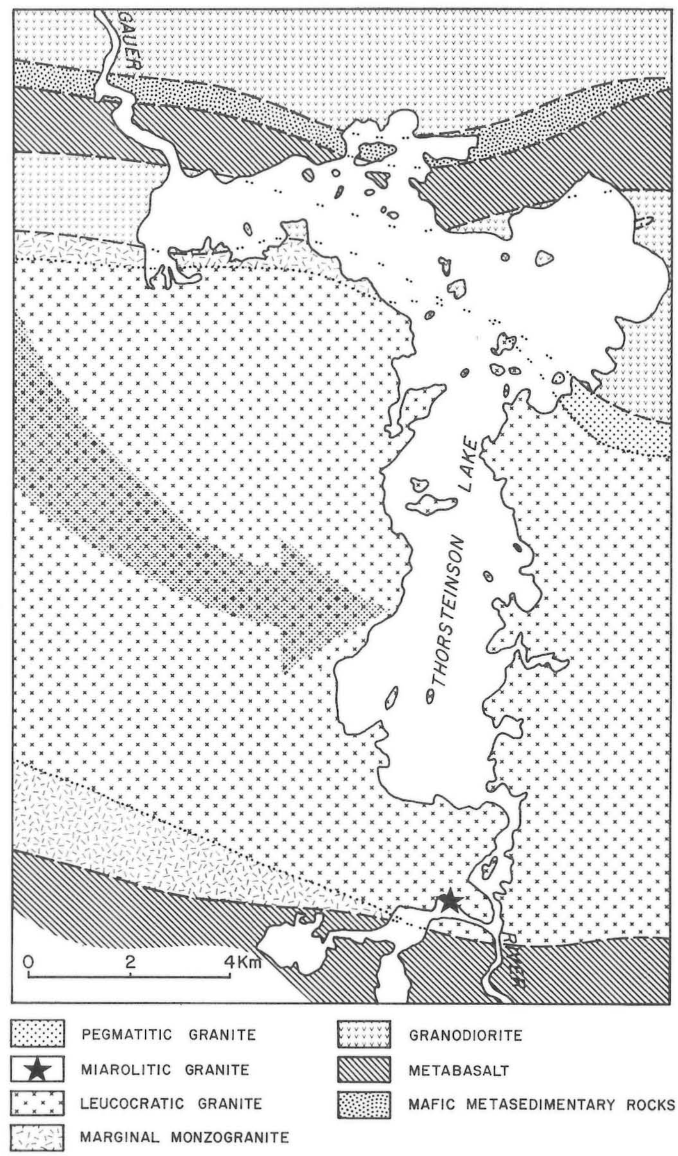

Figure GS-4-4: Generalized geology of Thorsteinson Lake showing the distribution of textural phases in the granite. The stippled arrow shows the general trend of differentiation.

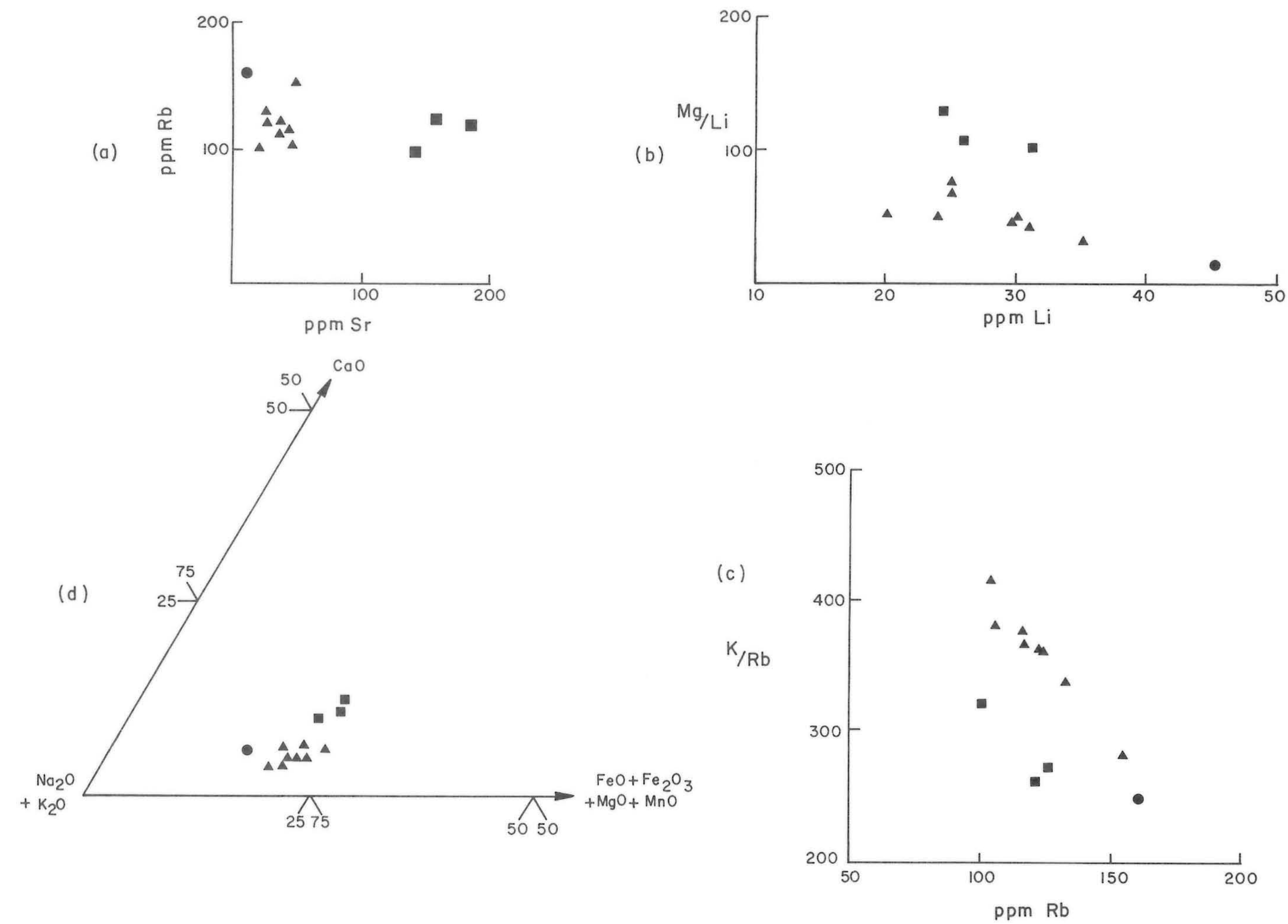

Figure GS-4-5: Selected geochemical relations for three phases of the Thorsteinson granite. Squares indicate marginal monzogranite, triangles coarse leucocratic granite and the circle miarolitic granite. Note the Sr depletion and the general trend toward more alkaline compositions with increasing fractionation.

The marginal monzogranite is a pink medium grained foliated granite. It is slightly peraluminous ($Al_2O_3/CaO + Na_2O + K_2O$ in mol proportion is 1.019 to 1.051 averaging 1.031) and contains 2 per cent biotite and traces of magnetite and allanite. Plagioclase typically shows normal zoning. Inclusions of partly assimilated granodiorite into which it intruded are common.

Seriate porphyritic, coarse grained, leucocratic granite is the main phase of the intrusion. It is quartz-rich, contains 1 per cent or less biotite and has traces of magnetite, allanite and apatite. It is metaluminous (A/CNK is 1.021 to 0.957, averaging 0.991). Plagioclase is unzoned and more albitic than the marginal phase. Pegmatite dykes with sharp intrusive boundaries and widths upto 3 m are common. Tourmaline is common in the pegmatite.

The miarolitic granite is restricted to the south margin of the intrusion. It is a coarse, red, leucocratic granite, similar to the main phase, with scattered irregular to oval pods of microcline quartz pegmatite. The granite is dominantly microcline and quartz with subordinate albite and biotite and traces of fluorite, magnetite, sphene and allanite. Total alkalii content is high and calcium low. This represents the most differentiated phase analyzed to date.

Pegmatitic granite was encountered only on the northeast margin of the body. It is a coarse red leucocratic granite containing numerous 30 cm graphic microcline megacrysts (Fig. GS-4-6). Megacrysts commonly are club-shaped, occurring in the granite but rooted in narrow pegmatite veins. Tourmaline is abundant as fine disseminations in the granite and large columnar crystals in the pegmatite veins.

The limited amount of geochemical data available indicates differentiation increases in the body from north to south. There is some indication of increase to the east, but this is not clearly shown. Although the data base is not adequate for a statistical evaluation, the geochemical indicators of Beus and Sitnin (as presented in Trueman and Cerny, 1982) suggest pegmatites derived from the granite are probably not enriched in rare elements as a source of rare elements.

PARTRIDGE BREAST LAKE

Two prominent exposures of pegmatite were examined in the eastern end of Partridge Breast Lake. They are shallow dipping (less that 20°) dykes with asymmetric zoning.

The smaller body is a 3 m thick dyke and comprises three textural units: a basal, laminated, garnetiferous aplite, an overlying pegmatite with a well developed quartz core, and a coarse plagioclase-quartz-biotite-muscovite-garnet granite formed by late stage hydrothermal albitization of the pegmatite and aplite.

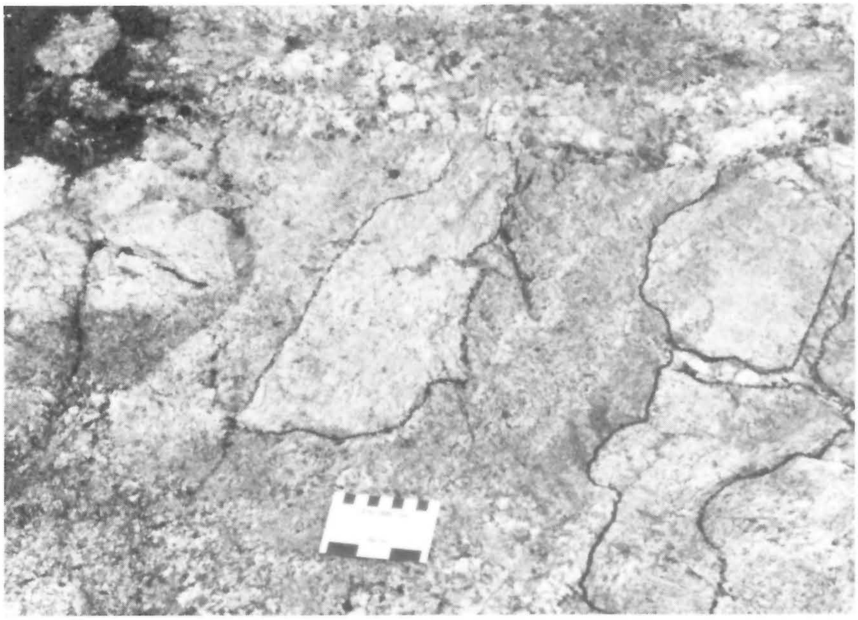

Figure GS-4-6:

Large club-shaped graphic microcline cyrstals (outlined in black ink) rotted in a thin pegmatite seam and surrounded by coarse leucocratic granite. Northeast shore of Thorsteinson Lake in the pegmatitic granite phase.

The core zone comprises massive white quartz surrounding large, blocky, non-graphic microcline crystals. Coarse biotite is concentrated along the core margins. Above the quartz core the dyke is dominantly large, irregular microclines with graphic cores and non-graphic rims surrounded by quartz, muscovite and biotite. Below the core is a narrow zone of blocky microcline, biotite and garnet. Laminated aplite forms the lowest unit. Laminae are molded around the base of some large microclines which extend downward from the overlying zone. The aplite is a white, fine grained, feldspar-rich rock with rare 5 cm microcline megacrysts. It contains thin (1-3 mm) seams of garnet-rich rock and 1 cm layers of pegmatite.

The second body is a 30 m thick dyke comprising alternating 1 to 5 m thick layers of pegmatite and coarse, red granite with discrete pegmatite pods. The granite contains muscovite, quartz, feldspars, tourmaline and garnet. Biotite occurs only in the pegmatite.

CONCLUSIONS

While textural and chemical evidence obtained to date indicate several of the bodies examined are well differentiated products of granitic crystallization, no evidence exists for rare element enrichment in these occurrences. Further geochemical studies on mineral samples collected from the described occurrences will elucidate the potential of this type of body as a source of rare elements.

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GS-5 FLIN FLON — SCHIST LAKE AREA

(parts of 63K/12, 13)

by A.H. Bailes and E.C. Syme

INTRODUCTION

Mapping at a scale of 1:15 840 was conducted for part of the 100 km^2 Flin Flon-Schist Lake map area (Fig. GS-5-1), with the remainder to be completed in 1983. This project is a continuation of the mapping program carried out in 1979-1981 in the adjacent White Lake-Mikanagan Lake area (Bailes and Syme; 1979, 1980). Primary objectives were a stratigraphic subdivision of the Amisk Group in the Flin Flon area and placement of mineral deposits within the stratigraphic framework. Major findings during this year's field work include the definition of two fault-bounded blocks of differing volcanic stratigraphy, definition of many areas of hydrothermal alteration, and the recognition of numerous folds and faults; the latter complicate the delineation of an overall stratigraphy for the area.

STRUCTURAL SETTING

Mapping in the adjacent White Lake-Mikanagan Lake area defined five major fault-bounded blocks, each with a unique stratigraphic sequence which is not repeated in other blocks (Fig. GS-5-2). This pattern of block faulting is now known to continue into the Flin Flon-Schist Lake area, at least to the Manitoba-Saskatchewan border. The two blocks defined in the Flin Flon-Schist Lake area (Fig. GS-5-2) are:

(1) Manistikwan Lake Block, separated from the Bear Lake Block to the east by the Inlet Arm fault; and

(2) Flin Flon Block, separated from Manistikwan Lake Block by the Big Island fault.

Other faults, some of them major, occur within the blocks but do not separate terrains of significantly differing character.

The Manistikwan Lake Block is characterized by a homoclinal, west-facing sequence of aphyric intermediate to mafic flows. The Flin Flon Block on the other hand is characterized by a folded succession of aphyric and porphyritic intermediate to mafic flows. This block also contains a significant proportion of scoria-rich tuffs and tuff breccia. All of the presently known ore deposits in this map area occur in the Flin Flon Block. Both the Manistikwan and Flin Flon Blocks contain abundant syn-volcanic, mafic to felsic high level intrusions.

Folding is not a common feature in the adjacent White Lake-Mikanagan Lake area and in the Manistikwan Lake Block. However, four major folds are known in the Flin Flon Block (Fig. GS-5-2). They are the north-trending Burley Lake syncline (a moderately tight fold offset along the Phantom Lake fault), the Mandy Road anticline (along the east shore of Schist Lake adjacent to the Channing fault), an unnamed syncline west of Embury Lake that is terminated to the north and south against the Manistikwan Lake fault, and a broad anticline northwest of Hook Lake which produces an abrupt shift in bedding attitude from north-northwest (in the north) to southwest (in the south).

ALTERATION

The Flin Flon-Schist Lake area is characterized by abundant zones of hydrothermal alteration, much more alteration than in the White Lake-Mikanagan area. Alteration is present locally in all rocks west of the Inlet Arm fault. Although there are probably several ages of alteration, most appear to be syn-volcanic. The varieties of alteration recognized and identified on the Preliminary Map 1982W-1 are:

A) Epidotization: The intensity of epidotization is highly variable and only strongly epidotized rocks associated with other hydrothermal alteration features (e.g. pyritization, silicification) are shown on the Preliminary map. In volcanic rocks epidotization takes the form of a pervasive conversion to epidote-quartz or epidote-amphibole assemblages and partial to complete obliteration of primary structures and textures. In the syn-volcanic Cliff Lake tonalite pluton epidotization occurs adjacent to fractures and also in a more pervasive, less localized manner which affects large areas of the core of the pluton.

B) Silicification: Low intensity silicification probably accompanies epidotization but is difficult to distinguish in the field. It also locally accompanies carbonatization, producing, for example, bleached-looking mafic pillowed flows. Pervasive silicification is in some instances accompanied by silica net veining.

C) Pyritization: Small amounts of disseminated fine grained pyrite are common accompanying epidotization and silicification, producing local patches of rusty gossan. More intense zones of pyritization occur adjacent to the gabbro at the south end of Embury Lake, in the mudstone unit northeast of Big Island, and as a discontinuous envelope surrounding the Cliff Lake pluton. Intense pyritization almost completely masks the original rock type in these zones.

D) Silica networks, chlorite-sulphide veinlets: The two main areas where this type of alteration occurs are in the footwall to the Schist Lake Mine and in a wide zone at the south end of Embury Lake. The alteration occurs as patches containing fine networks of quartz veinlets, anastomosing chlorite veins and transposed veinlets, and associated irregular zones of pyritization. South of Embury Lake, large (up to 15 cm) oval epidote or epidote-quartz bodies, some with a concentric internal structure, accompany this alteration and occur in both flow rocks and in syn-volcanic dykes.

E) Carbonatization: This common form of alteration has a variable expression, including: (1) small discrete carbonate blasts comprising up to 40 per cent of the rock, (2) rusty-weathering carbonate veins and pods, and (3) carbonate matrix in brecciated rocks. Vein-type carbonate also occurs associated with fault zones but is not included as a hydrothermal alteration phenomenon. Three main areas showing carbonatization are (1) in the Stitt Island rhyolite and in the footwall to the Schist-Mandy ore zone, (2) along the west shore of the east arm of Manistikwan Lake, and (3) small areas in the north-central part of Big Island.

F) Tourmalinization: Quartz-tourmaline veins are commonly associated with the Cliff Lake pluton. Locally, tourmaline blastesis occurs adjacent to these veins. Baldwin (1980) reports tourmaline-filled breccias in two localities within the Cliff Lake pluton.

G) Hematization: This type of alteration occurs in the Cliff Lake pluton, accompanying epidotization. It produces pink feld-

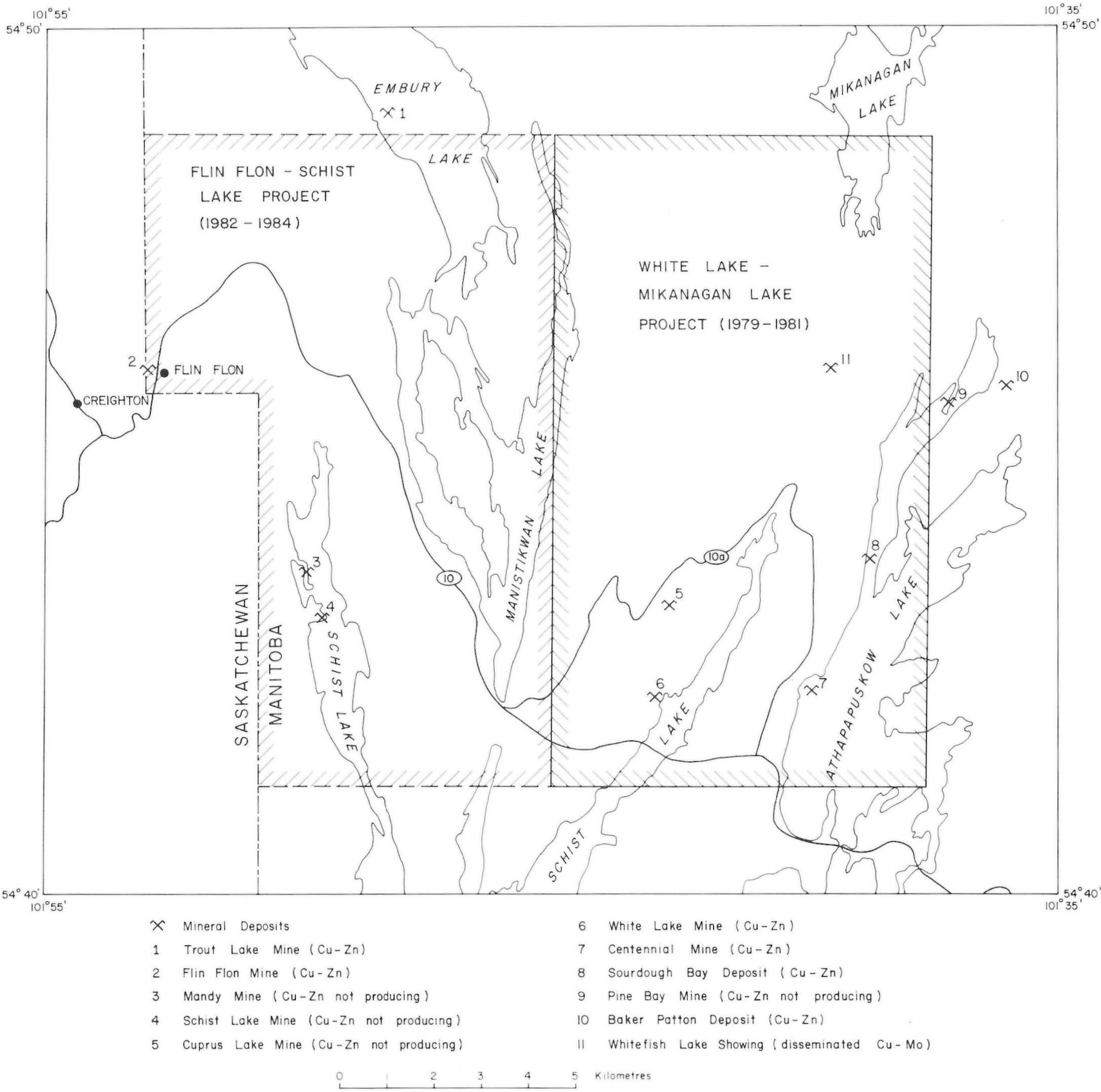

Figure GS-5-1: Location of Flin Flon-Schist Lake and White Lake-Mikanagan Lake project areas, and location of mineral deposits in the Flin Flon area.

spar and quartz crystals, due to hematite dust along intragranular fractures.

H) Magnetite blastesis: Development of disseminated magnetite crystals is common in the weakly epidotized outer portion of alteration zone within the the Cliff Lake pluton.

I) Discordant zones of spherulites: Zones of spherulites cross-cutting stratigraphy at a high angle occur in mafic flows at several locations west-northwest of Hook Lake. The spherulites are between 5 mm and 6 cm in diameter and are locally restricted to sharply bounded zones that are well defined and several metres wide. The zones trend across flow contacts.

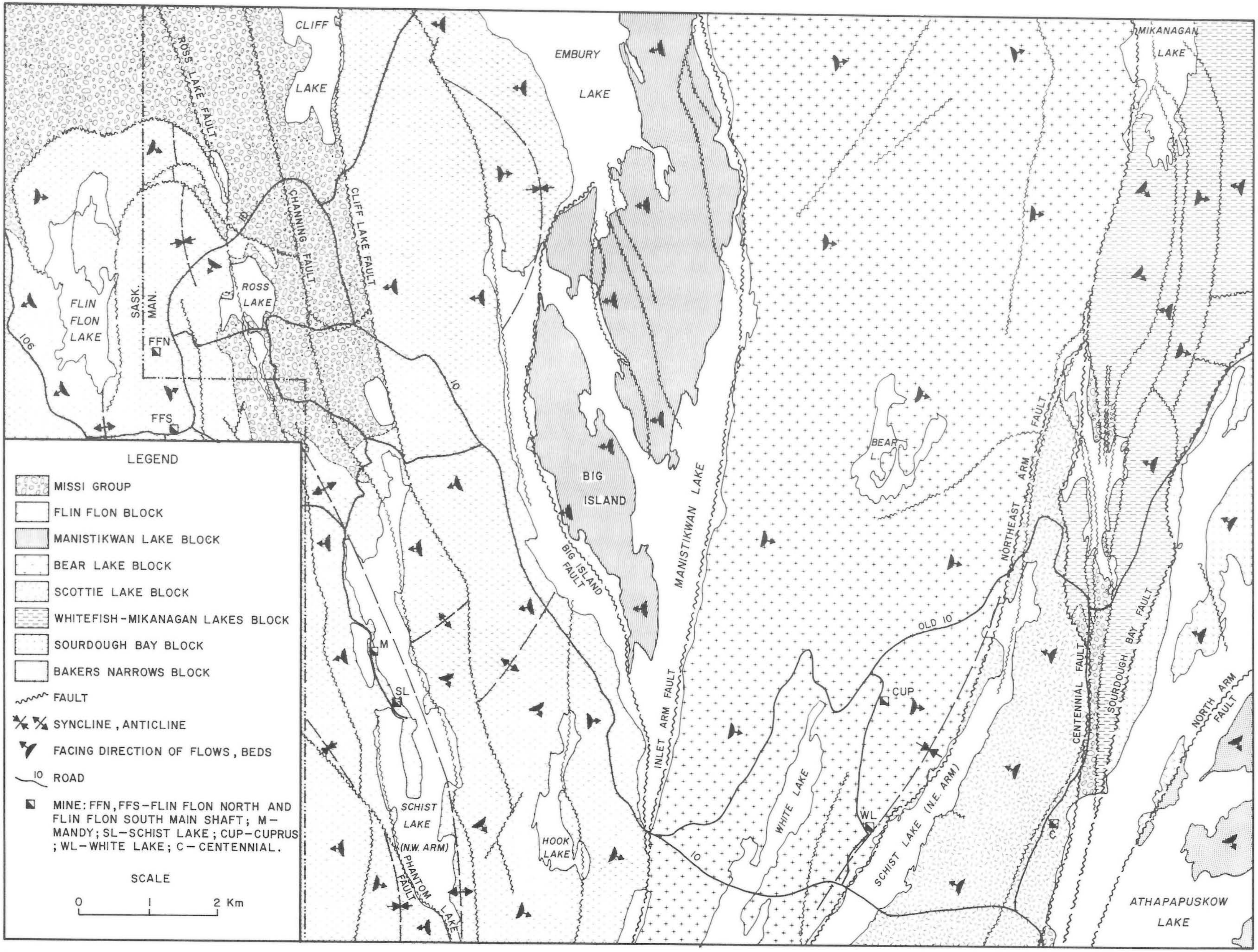

Figure GS-5-2: Faults, fault-bounded blocks and facing direction of strata in the combined Flin Flon-Schist Lake and White Lake-Mikanagan Lake project areas.

AMISK GROUP VOLCANIC AND SEDIMENTARY ROCKS

The Amisk Group in this area is composed of proximal facies volcanic rocks of mafic to intermediate composition. Features of this proximal volcanic facies are:

(1) an overwhelming predominance of flows and flow breccias and virtual absence of sedimentary rocks;
(2) the common occurrence of breccias derived by fragmentation of flows;
(3) an abundance of syn-volcanic dyke swarms;
(4) many syn- to late-volcanic intrusive bodies;
(5) the occurrence of numerous syn-volcanic hydrothermal alteration zones; and
(6) the presence of proximal-type Cu-Zn massive sulphide ore deposits.

All of the volcanic rocks were deposited in a subaqueous environment, although largely in shallow water.

Unlike the White Lake-Mikanagan Lake area, where different mafic volcanic units were distinguished in the field, similarities in rock type, composition and flow morphology in the Flin Flon-Schist Lake area largely preclude a simple breakdown of the mafic volcanic rocks. An absence of distinctive marker units (e.g. sedimentary formations) and the presence of numerous faults and folds does not permit construction of a continuous stratigraphic section for either block in the Flin Flon-Schist Lake area. The rocks are considered to be part of a thick volcanic succession; a minimum thickness of 3 km is identified near Hook Lake.

Intermediate to mafic flows (unit 1) are predominantly pillowed and have been subdivided according to phenocryst content. They are organized in a similar manner to basaltic andesite flows in the Bear Lake Block (Fig. GS-5-3). The Manistikwan Lake Block contains aphyric flows with virtually no porphyritic varieties; in this respect the flows are similar to basaltic andesites in the Bear Lake Block. In contrast the Flin Flon Block is characterized by porphyritic flows, interlayered on a large scale with aphyric flows.

Pillow fragment breccias (unit 2) occur as interflow beds and as thick mappable units. They are stratified, with beds ranging from 50 cm to 20 m thick. Beds are massive or graded, with grading defined by decrease in fragment size and fragment to matrix ratio in the upper portion of the bed. Reverse grading occurs in some thick beds. Fragments are commonly porphyritic, angular to subrounded and variable in vesicle content. Pie-shaped fragments, crescentic fragments and oval pillows are diagnostic as they indicate that these breccias were formed from disintegration of pillows along radial and concentric fractures. Matrix for these breccias is composed of pillow granules, pillow selvage fragments, crystals and fine grained material. Most beds are monolithologic but variation can occur in phenocryst content between beds. In addition some beds are heterolithic, indicating partial mixing during transport. Pillow fragment breccias were formed by at least two processes:

(1) the cold fragmentation of pillowed flows and subsequent mass movement and redeposition of pillow fragments; and
(2) **in situ** fragmentation of pillows during extrusion.

These breccias differ from amoeboid pillow breccia, the other major type of breccia in a mafic pile. Amoeboid pillow breccias are an integral part of pillowed and massive flows and consequently do not form mappable units. In many flows it can be demonstrated that the amoeboid pillows formed by budding from the underlying massive or pillowed division.

Scoria-rich lapilli tuff and tuff breccia (unit 3) are pyroclastic, stratified rocks with beds 20 cm to 14 m thick. They commonly display graded bedding and in some instances contain Bouma zonation including parallel and ripple laminations. They are characterized by being crystal rich and containing abundant intermediate to mafic scoriaceous lapilli. Beds commonly contain accidental fragments an order of magnitude larger than the scoria lapilli; these accidental fragments are non-vesicular to strongly vesicular, angular to rounded flow fragments. In many instances these large blocks occur in portions of the bed where they were obviously not in hydraulic equilibrium at the time of deposition. Bomb sags occur beneath some of these accidental fragments. Scoria-rich tuffs are interlayered with pillowed flows and pillow fragment breccias indicating a subaqueous environment of deposition. These rocks were probably formed from phreatomagmatic eruption of juvenile scoria with inclusion of accidental pillow fragments.

Subaqueous dacite and rhyolite flows (unit 4) are not common in the Flin Flon-Schist Lake area. A columnar jointed rhyolite flow has been traced laterally for 1.2 km at the north end of Manistikwan Lake. This flow, which is part of a large composite rhyolite complex, is described by Syme **et al** (1982, p. 23). The only other major felsic body occurs on Stitt Island where a carbonatized, silicified dacite forms a unit at least 300 m thick. It is sparsely quartz phyric, locally columnar jointed, and massive to crackled.

Volcanic conglomerate (unit 7) with plutonic clasts occurs east of Embury Lake and near the south margin of the map area, east of Schist Lake. The conglomerate east of Embury Lake abuts at a high angle against truncated flows and gabbro intrusions and is probably a talus or scarp breccia. It contains gabbro clasts identical to those in the adjacent intrusion. The conglomerate is non-sorted, massive to poorly bedded, with a high proportion of intrusive rock fragments including quartz-phyric tonalite, equigranular gabbro, and pyroxene-phyric gabbro, in addition to a variety of intermediate to felsic rock fragments. Large tonalite boulders up to 2.5 m across are common. The conglomerate at Schist Lake is organized into poorly sorted beds up to 15 m thick that contain angular clasts of coarse gabbro, syn-volcanic dyke material, equigranular quartz diorite and assorted intermediate volcanics. It is interpreted as a debris flow deposit.

Greywacke and mudstone (unit 8) occurs in a single mappable unit, in the hanging wall of the Schist-Mandy ore zone. Beds are mafic in composition, 2-100 cm thick and grade to mudstone tops. They contain plagioclase and pyroxene crystals and rare pyroxene-plagioclase-phyric volcanic clasts. Pyritic mudstone (unit 9) occurs at the south end of Embury Lake and in a 250 m thick heavily gossaned unit northeast of Big Island.

INTRUSIVE ROCKS

At least 30 per cent of the Flin Flon-Schist Lake area is composed of syn-volcanic intrusive rocks ranging from narrow feeder dykes to a large plutonic complex. They vary in composition and texture from aphanitic high-level rhyolite to coarse grained gabbro and tonalite. No age relationships are implied by position in the legend (Preliminary Map 1982W-1). Some of the units, for example unit 12 gabbro and diorite, are texturally highly variable and include rocks of varying age. Descriptions of the more prominant intrusive units are given below.

Differentiated coarse grained gabbro and quartz diorite (unit 13) are texturally and compositionally similar to major strongly differentiated gabbroic sills in the White Lake-Mikanagan Lake area (Bailes and Syme, 1980). Some of these bodies are syn-volcanic: the intrusion west of Hook Lake is cut by vesicular high level mafic dykes, and clasts of a similar gabbro occur in unit 7b conglomerate.

Narrow dykes, dyke swarms, small plugs and breccia plugs of rhyolite (unit 14) occur widely in the area bounded by the Inlet Arm fault and the Channing fault. The rhyolite is aphyric to quartz phyric, very fine grained, and shows some features of flows including flow banding, vesicles, breccia zones, and **in situ** fragmentation. However, rhyolite bodies cross-cut stratigraphy and have intrusive

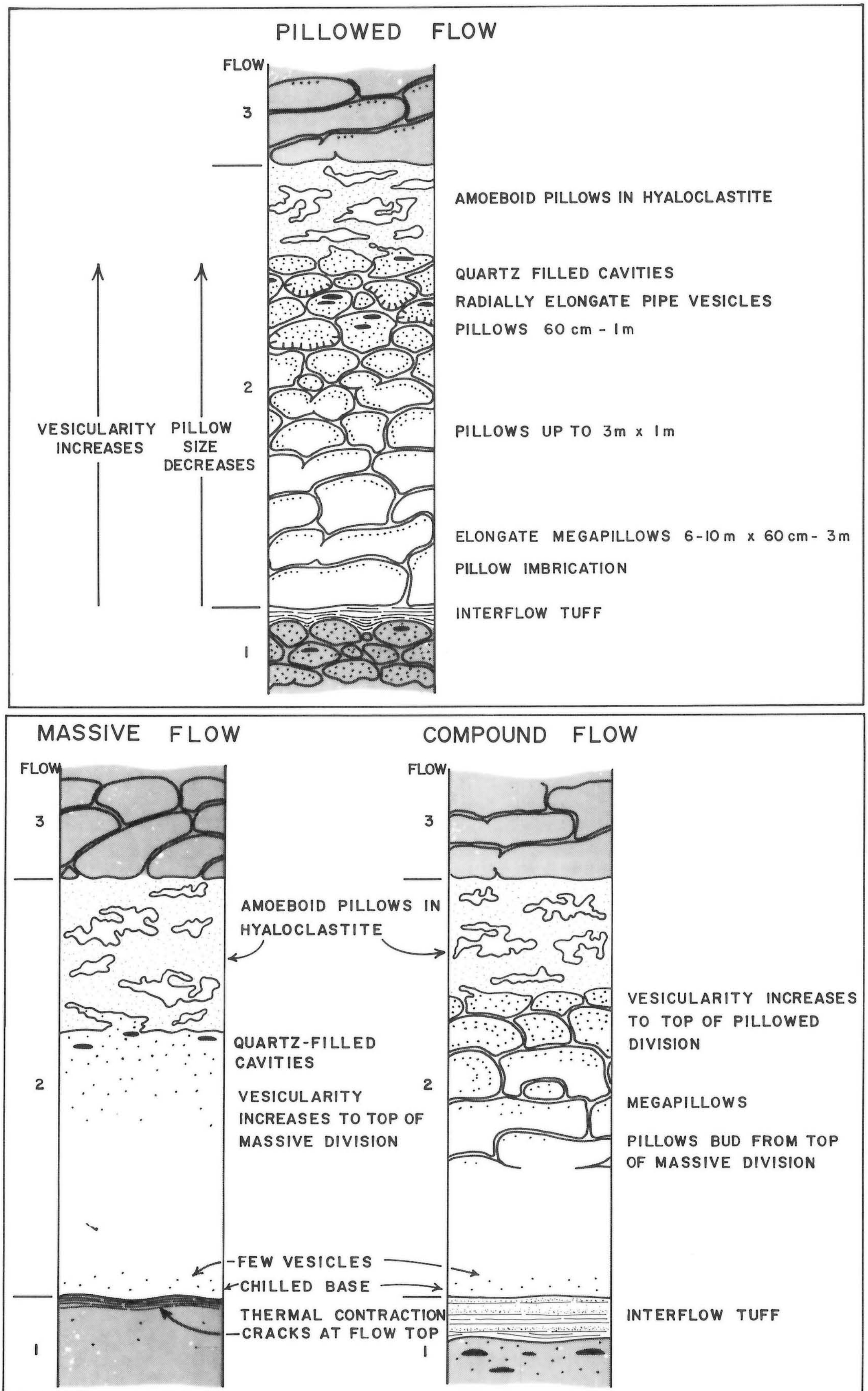

Figure GS-5-3: Common features in pillowed, massive and compound intermediate to mafic flows in the Flin Flon, Mikanagan Lake and Bear Lake Blocks. Numbers beside columns refer to individual flows.

margins. These intrusions are particularly abundant in the Hook Lake area, south and east of the Cliff Lake pluton, and northeast of Big Island. They are typically associated with fine grained diorite or gabbro dykes which are younger than the rhyolite.

Quartz porphyry (unit 15) occurs principally on Big Island and at the south end of Embury Lake. Two non-gradational textural types can be defined. One contains up to 20 per cent 1-3 mm quartz phenocrysts (unit 15a) and the other contains up to 30 per cent 1-10 mm quartz phenocrysts (unit 15b); the latter may contain up to 30 per cent 1-3 mm plagioclase. Quartz porphyry of both types is mainly massive but includes rare breccia and lapilli tuff. Intrusive contacts with intermediate-mafic volcanic rocks indicate most of the quartz porphyry is intrusive; it is likely high-level and syn-volcanic.

The Cliff Lake pluton (unit 17) is a lens-shaped body 8 km² in area. Baldwin (1980) interpreted it to be syn-volcanic and reported occurences of Cu and Mo mineralization. Our mapping indicates it is a high level intrusion with six phases, only three of which form mappable bodies. The six phases described below are listed in order from oldest to youngest.

(1) Quartz diorite (unit 17a) is equigranular to porphyritic. It has a grain size of 1-3 mm and is composed of 5-15 per cent quartz, 40-60 per cent black amphibole, plagioclase, and sporadic quartz phenocrysts up to 8 mm. Quartz diorite forms mappable bodies within the pluton as well as large (up to 300 m) xenoliths within the younger tonalite (unit 17b). Some "quartz diorite" has been produced by recrystallization and quartz blastesis of intermediate-mafic volcanic xenoliths within the pluton, suggesting that this phase may have been produced by recrystallization and partial assimilation of host volcanic rocks.

(2) Quartz-phyric tonalite is the major component of the Cliff Lake pluton. It contains 20-40 per cent quartz phenocrysts up to 1 cm across, 1-3 mm plagioclase crystals and variable amounts of clotty amphibole and chlorite. The tonalite is subdivided into three main phases on the basis of abundance and degree of assimilation of xenoliths:

    (17b) This phase, which occurs along the western margin of the intrusion, has abundant large mafic volcanic and quartz diorite xenoliths (up to 300 m in maximum dimension). The xenoliths are typically between 10 cm and 1 m long, tabular and aligned with long axes parallel to one another.

    (17c) This phase forms the central area of the pluton and contains abundant small (1-2 cm), round, highly assimilated mafic to intermediate xenoliths. It is younger than unit 17b.

    (17d) A separate oval plug on the east side of the pluton contains few, small, highly assimilated xenoliths. It is bordered on the west by a fault and a narrow, discontinuous, linear sliver of volcanic rocks. The plug is cored by an extensive zone of hydrothermal alteration.

(3) Fine grained quartz-phyric tonalite or granodiorite (unit 17e) comprises small plugs and dykes cutting the quartz-phyric tonalite. This phase has fewer and smaller quartz phenocrysts than the main tonalite, and a very fine grained groundmass.

(4) A leucocratic quartz-phyric tonalite forms a marginal phase in the northern part of the pluton.

(5) A hornblende-phyric tonalite, more mafic than the main phase tonalite, occurs locally, notably as dykes adjacent to the central fault cutting the pluton.

(6) Fine grained, locally quartz-phyric pink aplite occurs as narrow dykes and plugs which cut all tonalite phases.

The Cliff Lake pluton is intruded by gabbro and abundant, narrow fine grained dykes of quartz diorite and diorite. Many of these late dykes follow fracture systems within the pluton.

Magnetite-bearing quartz diorite and diorite (unit 18) occurs as major bodies on Big Island and on the penninsula east of Big Island, and as numerous small dykes in the same areas. It is characterized by the presence of fine grained disseminated magnetite (up to 10 per cent). Rare vesicles in the fine grained margins of the intrusions suggest that they are high level bodies. Magnetite-bearing quartz diorite and diorite are cut by unit 19 quartz diorite and diorite.

Quartz diorite and diorite (unit 19) includes intrusions of many different ages, but most are late. Major bodies occur on Big Island (intruding quartz porphyry, unit 15) and at the south end of Hook Lake (intruding differentiated gabbro, unit 13). The intrusions are complexes composed of many individual dykes or phases. Quartz diorite and diorite are equigranular with a grain size of 1 mm; some narrow dykes are vesicular and probably very high level.

CONCLUSIONS

Amisk volcanic rocks in the Flin Flon-Schist Lake area are subaqueous, proximal, and characterized by pillowed flows, related breccias and abundant syn-volcanic intrusions. Block faulting is widespread and similar to that identified in the adjacent White Lake-Mikanagan Lake area, making this a prominent structural element in the Flin Flon belt. A simple stratigraphic subdivision of the volcanic rocks in the Flin Flon-Schist Lake area was not possible on the basis of field mapping due to the monotonous nature of the volcanic pile and because of complexities introduced by major faults and folds within fault blocks. The presence of abundant, diverse hydrothermal alteration phenomena suggests there is continued potential for discovery of new mineral deposits in this already productive mining area.

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GS-6 WALKER LAKE PROJECT

(parts of 63 I/10, 11, 14, 15)

by J.J. Macek and F.G. Zimmer

INTRODUCTION

Geological mapping (1:50 000) was conducted in the Walker, Fairy and Bjornson Lakes area to obtain:

a) regional lithologic and structural data in the transition between the greenstone belts, the plutonic domain and the high grade Pikwitonei domain of the Gods Lake subprovince,
b) detailed coverage of the western termination of the Carrot River greenstone belt, and
c) to establish whether the economically important pegmatitic granites known from Cross Lake extend eastward into the Walker Lake region.

Outcrop conditions are good along the shorelines of Walker Lake and Walker River between Walker Lake and Bjornson Lake. In contrast outcrops at smaller lakes and inland are lichen or moss covered and unsuitable for detailed geological surveys. At Bjornson Lake, bedrock is well exposed but sporadic.

During the last week of the field season the collection of lithological and structural data was completed on several critical outcrops in Setting Lake. The evaluation of data is in progress.

GENERAL GEOLOGY

The Walker, Fairy and Bjornson Lakes area is underlain by cataclastic gneiss, migmatite and weakly foliated granite-tonalite bodies which are intruded by pegmatite veins and a few diabase dykes of the Molson Dyke Swarm. Granitic rocks contain numerous zones rich in amphibolite rafts and inclusions. In several locations these amphibolites are of metavolcanic origin.

A 9 km long, east-trending bay on the eastern side of Walker Lake is underlain by a tightly folded, sheared and poorly exposed metavolcanic metasedimentary sequence with sporadic outcrops of ultramafic rocks (metaperidotite) which represents the western termination of the Carrot River greenstone belt.

GNEISS-MIGMATITE DOMAIN

The dominant rock units in the Walker Lake area are pink to light grey, medium grained, weakly to strongly foliated, biotite granite-granodiorite gneiss and pink to light grey porphyritic granite-gneiss (equivalent to unit 8 in Bell, 1961). Gradational contacts indicate that they are genetically closely related.

These orthogneisses are generally homogeneous but contain sporadic mafic inclusions and schlieren. Irregularly distributed zones containing numerous rafts and inclusions in various stages of assimilation (Fig. GS-6-1) are also observed. In such cases the granite gneiss becomes enriched in hornblende. The inclusions are dominantly amphibolite, migmatized amphibolite, migmatite and gneiss. Rarely the supracrustal origin is recognizable on the basis of preserved pillow structures (Fig. GS-6-2). Inclusions of recognizable metasedimentary origin were observed only in a few cases.

The distribution and orientation of the rafts and airphoto lineaments suggest that equigranular and porphyritic biotite-granites were emplaced as elliptical bodies into a terrain of supracrustal rocks and migmatite-gneiss. The original structural grain is preserved in number of places as gneissosity, metamorphic layering in migmatites, or migmatized amphibolites (Figs. GS-6-3, 4, 5, 6 and 7). It is also preserved as the preferred orientation of rafts and schlieren in the gneiss or migmatite.

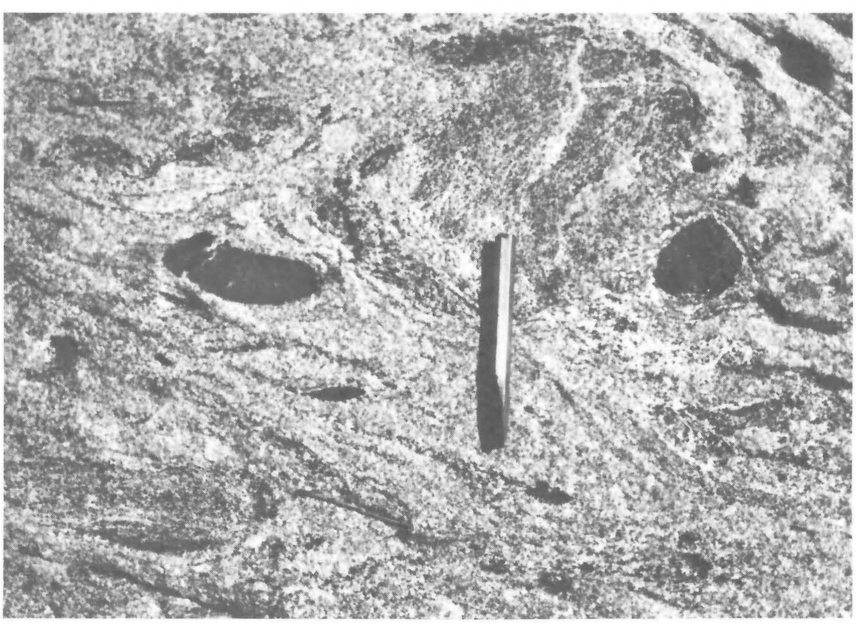

Figure GS-6-1:

Zone of numerous rafts and inclusions (amphibolites) in various stages of assimilation.

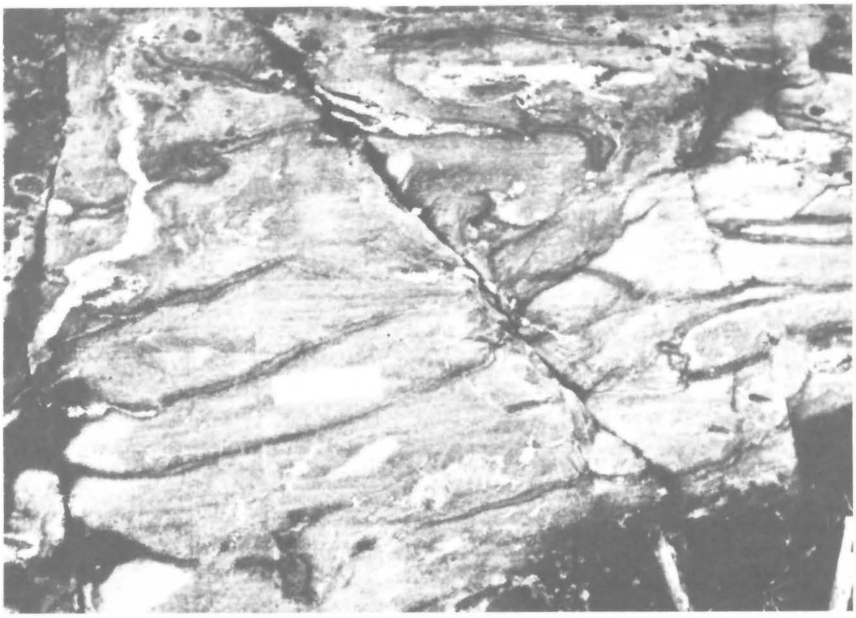

Figure GS-6-2:

Amphibolite with preserved pillow structure.

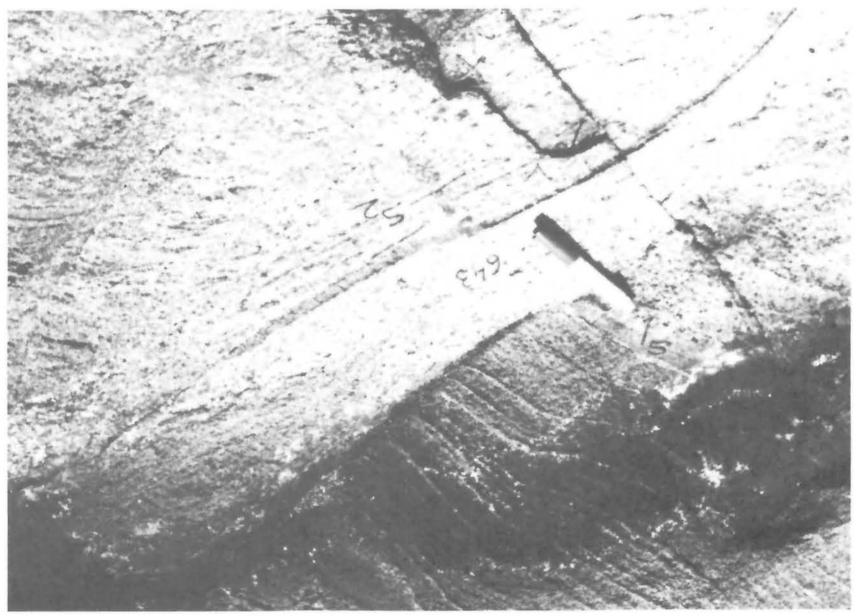

Figure GS-6-3:

Biotite-quartz-feldspar gneiss with S_1 layering and foliation cut by S_2.

During a post-intrusive, dominantly cataclastic event this original structural grain was transposed into a structural trend striking at 70°. At this time equigranular and porphyritic biotite-granites became gneissic.

Molson dykes (Scoates and Macek, 1978) represent the youngest rocks in the area. They intruded along north trending fractures which formed as a result of crustal extension in the early Proterozoic.

The lithological and structural relationships observed in the Walker Lake area conform with the order of events suggested by Hubregtse (1980).

GREENSTONE BELT

The narrow sliver of greenstones representing the western termination of the Carrot River greenstone belt is composed of metavolcanic and metasedimentary rocks. Metavolcanic rocks are dominant and represent three to six times the volume of the metasediments. They are sheared and recrystallized into texturally variable amphibolites and schists. Preserved textures suggest that the metavolcanic rocks represent a sequence of pillowed and massive flows of basaltic composition and associated hypabyssal sills. Igneous layering in metagabbro is preserved in a few places.

Isolated outcrops of serpentinized peridotite (Fig. GS-8-8) occur in close proximity with the metavolcanics. Their mutual relationship is not exposed. Nearby metavolcanic amphibolites are cut by a fault (226°/85°) which contains sulphide mineralization and secondary malachite. The showing was staked last year.

The metasedimentary sequence consists of light to dark grey, fine to very fine grained rhythmically layered rocks. The layering varies from laminae to thick (50-100 cm) beds. The sequence is interpreted as interlayered calcareous greywacke-subarkose and

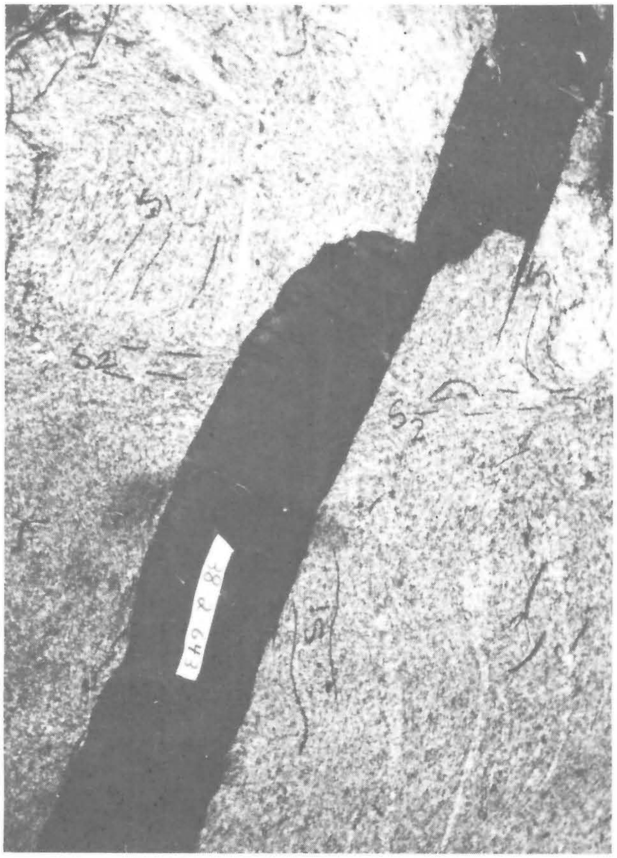

Figure GS-6-4:

Biotite-quartz-feldspar gneiss displaying relationship between S_1 and S_2 is cut by diabase of Molson Dyke swarm.

Figure GS-6-5:

Hornblende-biotite-quartz-feldspar gneiss with S_1 foliation (schlieren) gradually transposed into cataclastic S_2 foliation.

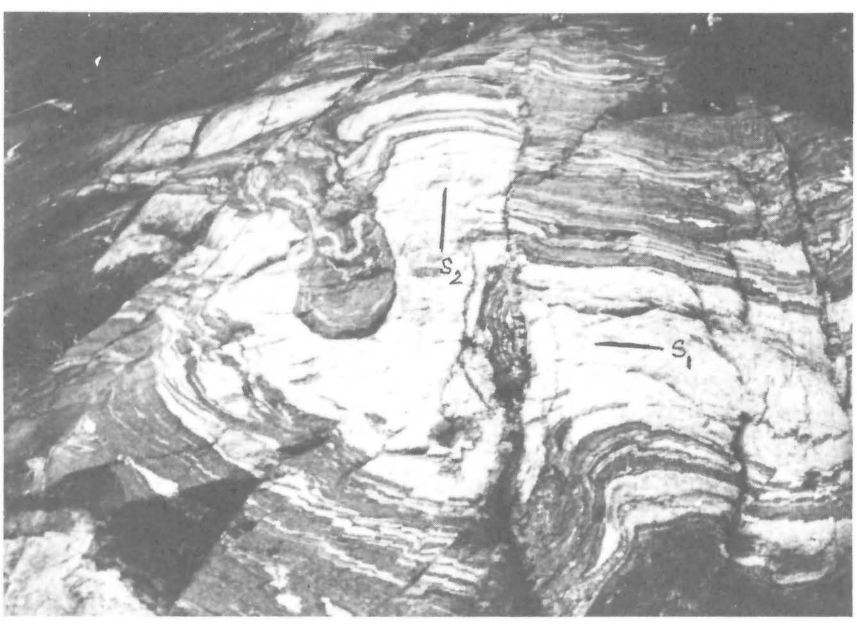

Figure GS-6-6:

Metamorphosed layering in migmatized amphibolites (S_1) being cut and transposed into cataclastic S_2 foliation.

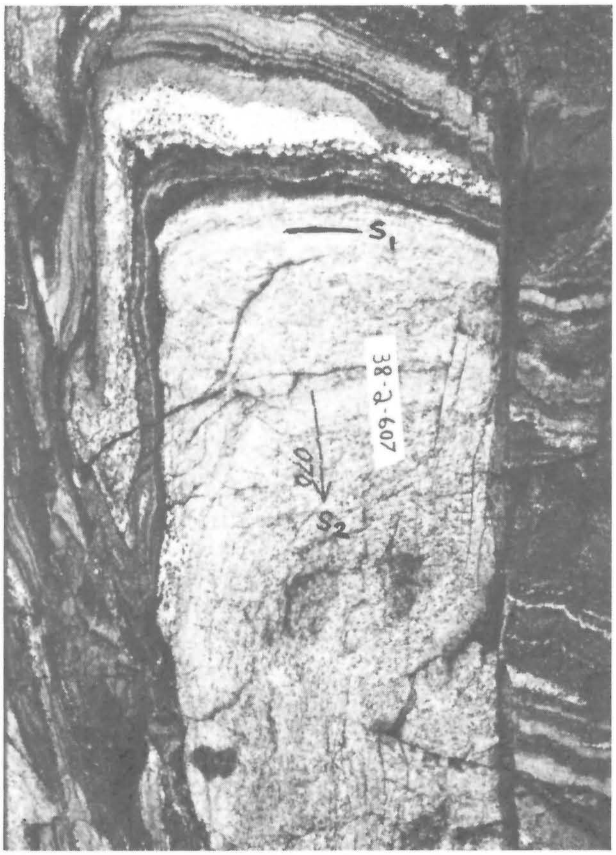

Figure GS-6-7:

Detail of features exhibited in GS-6-6.

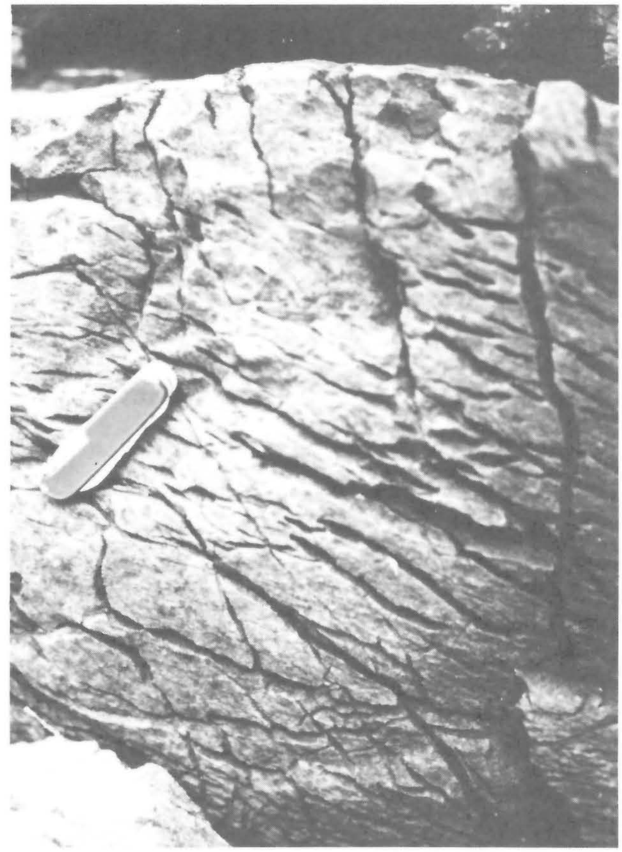

Figure GS-6-8:

Characteristic rhomb-shaped fracturing in meta-peridotite.

siltstone with local polymictic pebble conglomerate which contains clasts of greywacke, felsic volcanic, amphibolite, feldspar porphyry and quartz.

Closely associated with the metavolcanics and metasediments are fine grained, dark green-grey, poorly to well layered rocks commonly containing 2-3 mm long crystals of feldspars or amphiboles. These are interpreted as volcanogenic sediments.

Metavolcanics and metasediments are interlayered in a number of places. The exact stratigraphy is difficult to establish because of tight folding and lack of exposure in critical areas.

Pegmatites

Pegmatites are present on almost every outcrop in the form of veins (up to 1 m thick), and irregular pods and nests. They consist of potassium feldspar-albite-quartz-biotite with sporadic magnetite and tourmaline. Pegmatitic granite bodies, a possible source for the Cross Lake rare element pegmatites, were not found in the Walker Lake area.

The authors are grateful to our assistants L. Doig, D. Seneshen and S. Young for excellent support during the field season.

We also would like to thank our colleague T. Corkery for valuable help and professional input during his visit into the area and also for revising this manuscript.

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GS-7 ISLAND LAKE

(53E/15)

by W. Weber, H.P. Gilbert, K.L. Neale[1] and C.R. McGregor

INTRODUCTION

During this summer's field season four adjoining areas were mapped at a scale of 1:20 000, completing the geological coverage of the western third of the Island Lake greenstone belt (Fig. GS-7-1).

H.P. Gilbert resumed mapping (initiated in 1981) of the volcanic-sedimentary succession on Jubilee and Confederation Islands (53E/15SE), K.L. Neale completed the field work, started last year (Neale and Weber, 1981), on the sedimentary succession in Cochrane Bay (parts of 53E/15NE and NW) which will be the topic for a Master's thesis. C.R. McGregor mapped the tonalite batholiths at Bella Lake (part of 53E/15NE) and Waasagomach-St. Theresa Point (parts of 53E/15NW and SW). W. Weber coordinated the mapping and completed the coverage in the remaining area.

In addition, rock samples were collected for a U-Pb geochronology project in the northwestern Superior Province. Its goal is to date the major magmatic events and obtain a time-frame for the supracrustal rocks. Five samples were collected from the Oxford-Knee-Gods Lake area, to be analyzed by D. Davis, Royal Ontario Museum, Toronto. Seven samples were collected from the western Island Lake area, to be analyzed by A. Turek, University of Windsor, Ontario.

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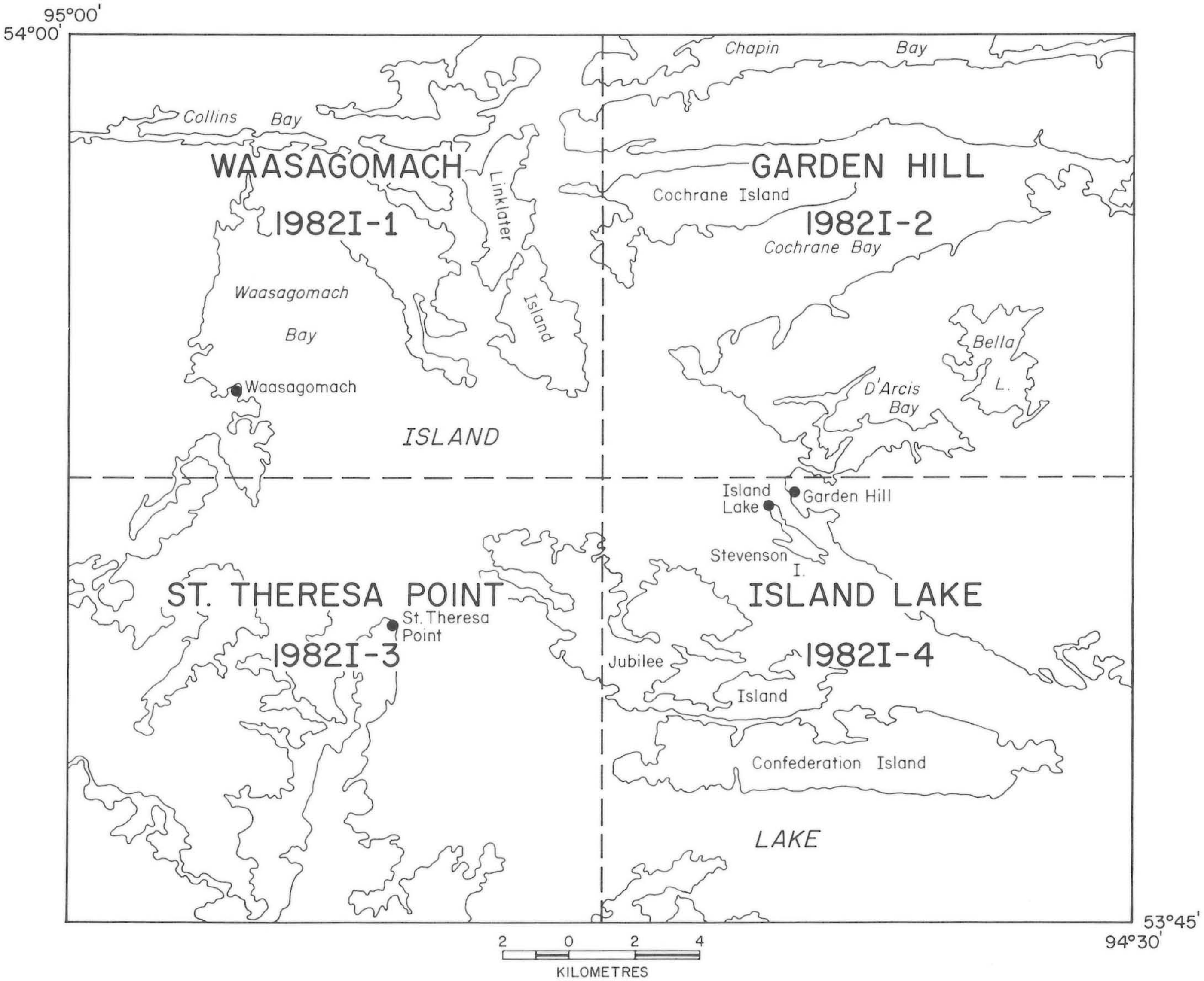

Figure GS-7-1: Map of Island Lake showing the geological coverage completed in 1982 (1:20 000) with Preliminary Map identification.

RESULTS OF FIELD WORK

The major geological events are shown in the Table of Formations (Fig. GS-7-2).

Several important age relationships were established. These will be critical to the definition of stratigraphic entities, e.g., Hayes River Group, Island Lake Group, to be undertaken after the next field season.

a) The Early Supracrustal Rocks (units 1-5) appear to represent a conformable succession which was isoclinally folded during the first period of deformation. The lithological association suggests entirely marine deposition. Units 1-4 consist of mafic to felsic metavolcanic and related volcanogenic sedimentary rocks, as well as related subvolcanic rocks. No more than one mafic-felsic cycle seems to be present, unless basalts in Cochrane Bay are part of a separate cycle, associated with the younger felsic unit 9. Unit 5 (Garden Hill conglomerate) probably represents channel fill deposits derived from a rising source to the north, possibly as a result of doming of the Bella Lake tonalite batholith (unit 6). This conglomerate, which had been assigned to the "Island Lake Series" by Godard (1963), is remapped as part of the Early Supracrustal Rocks since it is apparently conformable with rocks of unit 4.

b) Three tonalite batholiths (unit 6) occur in the western part of the Island Lake greenstone belt (see below). The Waasagomach and Bella Lake tonalite display intrusive relationships with unit 1. The Bella Lake and Chapin Lake tonalites are overlain by a regolith of unit 10. Mineralogical characteristics and relationships suggest these batholiths are comagmatic and possibly part of a single intrusive complex at depth, according to the model presented by Gupta et al. (1982). Tonalite of unit 6 is also exposed in the central part of the greenstone belt, east of Linklater Island ("Bunny Island tonalite").

c) The Late Metasedimentary Rocks, units 10 and 11, are now recognized as a conformable succession which overlies tonalites of unit 6; a regolith occurs at the base in many places.

The regolith is overlain by a fluvial succession derived locally from a hinterland, composed of tonalite and mainly mafic metavolcanics, which in turn is overlain by a fluvial succession derived from a more distal, mainly felsic volcanic source.

This fluvial succession grades upwards into a marine sequence characterized by turbidity current deposits (unit 11).

The volcanogenic conglomerates were initially interpreted to represent submarine channel fill deposits resulting from turbidity currents (Neale and Weber, op. cit.). Detailed work now indicates that the typical turbidite deposits (unit 11), interpreted by Godard (1963) as part of the Hayes River Group, stratigraphically overlie the fluvial succession (unit 10), representing a deepening of the basin.

In contrast to the Early Supracrustal rocks (units l-5), rocks of unit 10 and 11 are not isoclinally folded. They have been locally deformed by two younger events:

i) Z-folding (with steep NW-plunging axes) associated with a NW-trending major shear zone as a result of dextral displacement along the southern margin of the Bella Lake tonalite;

ii) E-W folding (with shallow to moderately steep W-plunging axes) in the Cochrane Island area, as a result of uplift of the Chapin Bay tonalite relative to the greenstone belt.

d) In the eastern part of Cochrane Bay the Late Metasedimentary Rocks are intruded by a tonalite-quartz diorite stock (12) with associated widespread felsic to intermediate dykes.

e) Mafic dykes of unit 13 occur in the central part of Island Lake. They trend in a generally northerly direction. The mineralogical composition suggests the dykes are recrystallized, and generally slightly deformed. Thus they are similar to late Archean dykes in the Molson-Kalliecahoolie Lakes area (unit 5, Weber and Schledewitz, 1981). An alternative, though less likely, interpretation would be that the dykes represent Molson dykes and that the central part of Island Lake was affected by the Hudsonian orogeny. Unmetamorphosed Molson dykes (unit 16) were only observed in the northern part of the lake, in Cochrane Bay.

f) Porphyry dykes of unit 14 truncate the tectonic fabric in the central part of the lake. Similar dykes in Cochrane Bay may be older and be related to the tonalite stock (unit 12).

g) Relationships of units 7 to 9 are less clear.

Metagabbro (unit 8) intrudes tonalite (6) in Waasagomach Bay. Serpentinized peridotite (7) is spatially closely associated with metagabbro (8) west, northwest and south of Linklater Island, at the east end of Stevenson Island, and west of Meegeesi Bay suggesting that unit 7 is part of a differentiated mafic-ultramafic intrusive cycle.

The spinifex-textured ultramafic rock east of Linklater Island (Theyer, 1977) is spatially associated with coarse grained meta-peridotites, metagabbro (8), and mafic flows and tuffs of unit 1 suggesting a relationship between some of the rocks of units 7 and 1 and possibly more than one mafic-ultramafic cycle.

h) Felsic metavolcanic rocks of unit 9 (and associated porphyries) are spatially separated from felsic metavolcanic rocks of unit 2 and are tentatively considered to be younger. However, further work is required to substantiate this assumption. Unit 9 may also be genetically related to tonalites (unit 6).

CARBONATES, CARBONATIZATION

Rocks considered to contain primary carbonate cement are carbonate-bearing siltstones and argillites in unit 4, and carbonate $\pm$ magnetite-bearing beds interbedded with chert in carbonate $\pm$ oxide facies banded iron formation (e.g., between Jubilee Island and Stevenson Island and on two islands near Linklater Island). Clasts of primary carbonate can be found in conglomerates of units 5, 9 and 10.

Zones of intense secondary carbonatization, affecting greywacke-argillite sequences parallel to bedding over a width of 100 m, are spatially closely associated with the carbonate facies iron formation. Intense carbonatization has led to the formation of a massive rock with an orange-brown weathered surface in which features of the original rock are completely obliterated. Rocks of units 8 and 9 near Stevenson Island and east of Linklater Island are locally pervasively carbonatized in sections up to at least 100 m. This secondary carbonatization is either metasomatic, related to the exhalative process which resulted in the adjacent iron formation, and/or related to late tectonic carbonatization, since in the Savage Island area further east such carbonatized zones truncate isoclinally folded metasedimentary rocks. No spatial relationship was observed between these carbonatized zones and ultramafic rocks, although tectonized, serpentinized ultramafic rocks contain considerable amounts of carbonate.

On several islands in the Stevenson Island area north-trending, massive, light cream carbonate dykes were observed. These dykes are clearly post-tectonic since they truncate the tectonic fabric. They occur in an area showing a high degree of pervasive carbonatization which suggests that the carbonate dykes are derived from remobilized carbonate. Thin quartz-carbonate veins and dykes occur in highly carbonatized zones.

PROTEROZOIC		16	Molson dykes
ARCHEAN	Post-Tectonic Plutonic Rocks	15	Granites (intruding Chapin Bay tonalite)
		14	Plagioclase + quartz phyric dykes
		13	Mafic dykes, metamorphosed
	Late Plutonic Rocks	12	Tonalite quartz diorite, felsic to intermediate dykes
			INTRUSIVE CONTACT
	Late Metasedimentary Rocks "ISLAND LAKE GROUP"	11	Turbidity current deposits: wacke, siltstone, argillite
		10	Regolith: wacke, breccia (on unit 6); fluvial deposits: tonalite-and volcanic-derived conglomerate, cross-bedded wacke, siltstone, argillite
			UNCONFORMITY
	Early Plutonic Rocks	9	Felsic metavolcanic rocks, related metasedimentary rocks, subvolcanic porphyries
		8	Mafic intrusive rocks
		7	Ultramafic intrusive, subvolcanic or flow rocks
		6	Tonalite batholiths (Bella Lake, Waasagomach, Chapin Bay, Bunny Island), related rocks
			INTRUSIVE CONTACT
	Early Supracrustal Rocks HAYES RIVER GROUP	5	Conglomerate, mainly sedimentary-derived
		4	Wacke, siltstone, argillite, conglomerate, chert, iron formation, carbonate
		3	Wacke, conglomerate, derived from felsic to intermediate pyroclastic deposits, interlayered with siltstone and argillite
		2	Felsic to intermediate metavolcanic rocks: flows, pyroclastics, and related subvolcanic porphyries
		1	Mafic to intermediate metavolcanic rocks: flows, tuffs, breccias and related subvolcanic gabbro sills

Figure GS-7-2: Table of Formations, Island Lake.

MINERALIZATION

Disseminated sulphides and small sulphide stringers are widespread in rocks of units 1 and 2, and less common in unit 3. Most sulphides are associated with gossans in silicified or sheared zones of mafic metavolcanic rocks(1). Several locations have been sampled for assay. A 1 m thick unit of intermediate tuff is mineralized with pyrite, pyrrhotite, chalcopyrite and sphalerite at the contact between pillowed basalt and overlying intermediate to felsic crystal tuffs close to the north shore of Jubilee Island (Canadian Occidental Petroleum Ltd., cancelled assessment data).[1] Pyrite, chalcopyrite and malachite occur within tonalite(6) at the isthmus at the south side of Jubilee Island, and disseminated pyrite is also common in the tonalitic Jubilee Island pluton(6). The tonalite of the Bella Lake area was subjected to detailed geochemical mapping and sampling in 1975 and 1976 (Haskins, 1977). It was assessed for copper, zinc, and molybdenum, but no economic mineralization was found. Sulphide mineralization is also locally associated with gabbro of unit 8 (R. Birch, pers. comm.). A molybdenum-copper showing at Bella Lake was recently blasted. Molybdenite and chalcopyrite are associated with a quartz vein which is bounded by cataclastic and silicified tonalite. Based on surface inspection the mineralization is of short strike length.

Locally, carbonate facies iron formation, porphyries(12) and carbonate dykes contain sulphides and should be prospected for gold, as well as quartz-carbonate veins in the highly carbonatized zones. The fluvial succession of conglomerates and cross-bedded sandstones shows potential for paleo-placer gold mineralization. A litho-specific geochemical sampling program should be undertaken.

GEOLOGY OF THE ISLAND LAKE AREA (53E-15SE). UNITS 1-8, 10

STRUCTURE

Nine folds have been identified in the Island Lake area; these occur mainly in the sedimentary parts of the succession (Island Lake area, Preliminary Map 1982I-4 and Figs. GS-7-3 and GS-7-4). Faulting probably occurs parallel to these major structures, and the axial planes of three folds south of Meegeesi Bay are interpreted to be faulted (Figs. GS-7-3 and GS-7-4). The northernmost syncline (at Meegeesi Bay) has been extrapolated northwestward through conglomerate(5) and is interpreted to be continuous with the syncline mapped in this formation further northwest (Garden Hill, Preliminary Map 1982I-2). Additional folds in the central and southern parts of the Jubilee Island section (BC, Fig. GS-7-3) can be inferred from igneous layering, and some pillow structure and sedimentary grading, but the data is unreliable. Minor folds and related linear structures plunge both east and west, but the majority plunge at moderate to steep angles to the east or southeast. The anticline just south of the Indian Reserve, however, plunges west-northwest.

Minor folds are generally tight to isoclinal, but some open folds have been observed. These structures are defined by either folded bedding or by deformation of both bedding and parallel foliation. The evidence suggests at least two fold phases with a regional foliation developed during the early phase. Strain slip cleavage oblique to bedding and the regional foliation occurs sporadically. Late minor faults cut the early structures at high angles. Strongly foliated zones parallel to the regional foliation are interpreted as relatively incompetent zones of shearing during the early phase of deformation. These zones are characterized by alteration of various lithologies to mafic and sericitic schists, by extreme deformation of fragments in conglomerate, and by local development of anastomosing zones of tectonic breccia in pillow basalt(1) and gabbro(8).

STRATIGRAPHY

The sections at the southern part of Jubilee Island and the eastern end of Confederation Island comprise the northern and southern limbs (respectively) of a synclinal fold, the axis of which extends along the north side of Confederation Island (Sections CB and GH, respectively, Figs. GS-7-3 and GS-7-5). A general correspondence between these sections is evident, with pillowed basalt comprising the oldest rocks, and sedimentary and felsic to intermediate volcanic rocks predominant in the overlying sequences. The western section (CB) is apparently more complex, although this may result from possible folding in this section, as described above. Interpretation of the northern parts of the cross-sections is limited by repeated folding (Fig. GS-7-4). These parts (sections DF and IJ), which are comprised largely of sedimentary and subordinate felsic to intermediate volcanic rocks, are interpreted as equivalent to the central and upper parts of the stratigraphic sections shown in Fig. GS-7-5.

METAVOLCANIC AND METASEDIMENTARY ROCKS

Mafic volcanic flows(1) comprise the oldest stratigraphic unit The thickness of this basal unit, together with a subordinate sedimentary unit, is 1240 m in the eastern section (GH, Fig. GS-7-5). The basalts are largely pillowed, locally amygdaloidal or vesicular, and rarely variolitic. Ovoid pillows are generally 0.5 m to I m long (rarely up to 6 m x 2 m), commonly with interpillow breccia or rare chert. Inter-flow gabbros (I m - 5 m thick) are widespread, and oligomictic flow-breccia units (I m - 3 m) occur locally. Several pillowed flows are carbonated and bleached. The concentration of vesicles in the upper parts of pillows and the form of intra-pillow vugs locally corroborate top directions indicated by pillow shapes. However, pillows are more typically moderately to strongly flattened, and locally pseudo-laminated. Thin (1 m), laminated mafic tuff interlayers(1) within the flows are rare. Units of amphibolitic or chloritic schist (0.5 m - I.5 m), which are more common, may represent tuffs or alternatively discrete shear zones within the mafic flows. Intermediate to mafic tuffs up to 30 m thick in the northern part of the western section (EF, Fig. GS-7-4) are recrystallized to well laminated amphibolites.

Predominantly felsic volcanic and related intrusive rocks(2) are associated with sedimentary rocks in a section (upto 800 m) thick in the lower part of the western section (CB, Fig. GS-7-5). Felsic tuff and crystal tuff comprise a major part of this unit; slight variations in crystal size and abundance of plagioclase and subordinate quartz locally define indistinct layering. However the tuffs are generally homogeneous over 5 m to 10 m thick sections. Fine sericitic and rare fuchsitic partings and laminae (up to 1 cm) of tectonic origin are characteristic. Sporadic felsic lapilli and rare mafic fragments comprise up to 5% of some units. Minor laminated cherty interlayers also occur within the tuffs. Subordinate interlayers of volcanic breccia contain felsic (and locally intermediate and mafic) clasts up to 50 cm x 4 cm. The occurrence of pumiceous fragments indicates a possible ash-flow origin in a felsic fragmental unit in the northern part of Jubilee Island (Corkery, pers. comm.). The same unit further east (south of Stevenson Island) contains unsorted polymictic breccia layers up to 30 m thick which are considered to be reworked pyroclastic deposits. Felsic to intermediate crystal-tuffs up to 160 m thick occur immediately north of the latter unit. These rocks are remarkably homogeneous, and considered to be primary tuff deposits in contrast to the reworked pyroclastic interlayers that occur within the sedimentary parts of the section (3, 4). Massive felsic to inter-

[1]For further information on the known mineralization and past mining activity see P. Theyer in Manitoba Mineral Resources Division Reports of Field Activities 1977-1982.

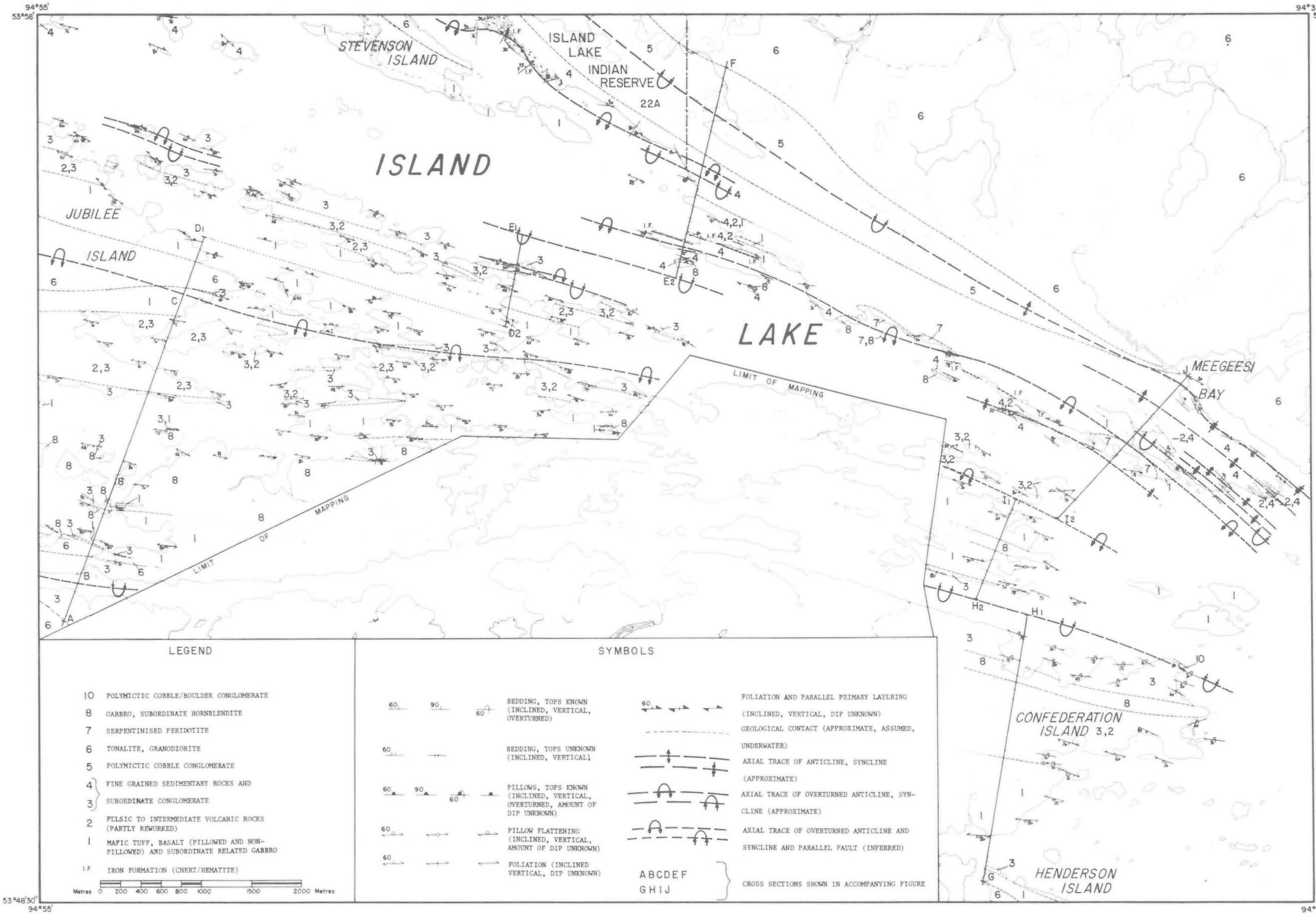

Figure GS-7-3: Geological map of the Island Lake area. Map units are indicated in order of abundance where more than one unit is shown. Cross-sections A-F and G-J are shown in Fig. GS-7-4.

mediate porphyritic flows and/or sills are locally associated with the fragmental rocks. Definitive evidence for extrusion has not been recognized, but some oligomictic fragmental zones may represent flow-brecciation. The thickest massive felsic unit (380 m) which is probably intrusive, occurs immediately above the basal mafic volcanic unit in the western section (CB, Fig. GS-7-5). These felsic rocks are generally only slightly foliated, in contrast to the crystal tuffs and breccias which are typically highly attenuated or altered to laminated felsic gneiss.

Sedimentary rocks (3, 4) are approximately equal in abundance to mafic volcanics in both western and eastern sections. The thickest monoclinal sedimentary section (1450 m) is developed in the upper part of the eastern section (Fig. GS-7-5), where it contains subordinate felsic to intermediate volcanic fragmental interlayers and a 160 m thick gabbro sill. The sedimentary rocks consist of a wide variety of lithologies including fine- to coarse-grained felsic to mafic feldspathic wackes, siltstones and argillite, pebbly wacke, and conglomerate and chert. These lithologies are commonly interlayered at a scale of 0.5 cm to 50 cm. Thicker, non-laminated units of feldspathic wacke and argillite (1 m - 5 m) also occur in unit 3 (at Jubilee Island); argillite units up to at least 20 m, and an unsorted conglomerate deposit 120 m thick occur within unit 4 (on the Indian Reserve, and in the area to the east (Fig. GS-7-3). Units 3 and 4, occurring to the south and north of the syncline at E respectively, are considered to be laterally equivalent. Unit 3 is characterized by the widespread development of felsic to intermediate volcanic fragmental interlayers which are partly to wholly reworked. Similar interlayers comprise only a minor part of unit 4, which contains relatively more argillite, and several chert/hematite iron formations (up to 20 m thick). Carbonatized feldspathic wacke occurs locally in unit 4, and a carbonate unit (4 m thick) occurs along the south shore of Meegeesi Bay. Detrital plagioclase is generally predominant over quartz in wackes of unit 3, whereas detrital quartz is locally abundant in unit 4, comprising up to 60% of some gritty wackes, and up to 15% of argillitic wackes; quartz pebbles also occur in conglomerate interlayers of unit 4. Graded-bedding, scour- and flame-structures, rip-ups and rare sedimentary folding are developed in the sedimentary rocks of both units 3 and 4. Cross-bedding is absent. Graded cyclic units (feldspathic wacke-siltstone-cherty siltstone-argillite) are locally developed. The sedimentary rocks consist largely of volcanic detritus, with some redeposited, intraformational interlayers. Chert is a very minor component. Cherty siltstone, which is more widespread, is interpreted as an epiclastic deposit with a chert matrix.

Polymictic pebble-cobble conglomerate of unit 5 (maximum thickness 620 m) occurs along the north side of the Island Lake greenstone belt (Fig. GS-7-3). Predominant clast-types include all fine grained sedimentary lithologies described in units 3 and 4; subordinate types include porphyritic felsic volcanics, quartz, and fine- to medium-grained massive tonalite and granodiorite; rare types include fuchsite schist, fragments of quartz-carbonate-chlorite veins (similar to those found intruding units 3 and 4) and pebble conglomerate clasts (apparently redeposited). Clasts are generally subangular to subrounded, ranging from pebbles to small boulders 30 cm across. The deposit is typically devoid of sorting in sections up to at least 50 m, but sorting of the rock into alternating layers and lenses of pebble- and cobble-conglomerate at a scale of 10 cm to 50 cm occurs locally. The feldspathic wacke matrix is moderately foliated and typically comprises approximately 60% of the conglomerate, which is clast supported; these features distinguish unit 5 from conglomerate interlayers within the fine grained sedimentary rocks (3, 4) which are matrix supported and generally well foliated to strongly attenuated and schistose. The conglomerate of unit 5 locally contains units up to 10 m thick of interlayered, graded feldspathic wacke and siltstone locally with flame structures. The contact between units 4 and 5 on the Indian Reserve is apparently conformable; both the contact and bedding in unit 4 have been folded together. However, the occurrence of several sedimentary clasts with foliations and feldspathic veinlets which are pre-depositional is enigmatic. The conglomerate(5) is interpreted to be largely derived from fine grained sedimentary rocks of units 3 and 4, indicating a relatively younger age, consistent with the structural interpretation (Fig. GS-7-3). Local interlayering of feldspathic wacke/siltstone units (similar to 3 and 4) with the conglomerate is consistent with a conformable sequence.

INTRUSIVE ROCKS

Medium grained, massive tonalite and granodiorite(6) intrude basalt at the southern side of the Island Lake greenstone belt (Fig. GS-7-3). "Quartz-eye" tonalite and granodiorite (Bella Lake pluton, unit 6) occurs north of the greenstone belt; the relationship between this pluton and conglomerate(5) in contact to the south is uncertain but the latter is considered to be relatively older because the pluton intrudes feldspathic wacke(4) which is interpreted as conformable with the conglomerate on the Indian Reserve. The granitoid rocks(6) at Meegeesi Bay contain 35% "quartz-eyes" (1 mm - 3 mm) and 10% microcline phenocrysts (4 mm - 2 cm).

The Jubilee Island pluton(6) is emplaced in the axial zone of the anticline in the north-central part of Jubilee Island. The tonalite is medium grained, massive to slightly foliated, and strongly foliated at the margins of the intrusion. Related felsic porphyry dykes with plagioclase and subordinate quartz phenocrysts (2 mm - 4 mm) are abundant in the aureole of this intrusion and similar porphyries intrude gabbro of possible unit 8 age; classification of the Jubilee Island pluton as unit 6 is thus provisional. Similar tonalite comprises a sill at the isthmus at the south side of Jubilee Island (Fig. GS-7-3).

Two lensoid intrusions of serpentinized peridotite(7) are emplaced in the sedimentary section(4) southeast of the Indian Reserve. These bodies are part of a series of ultramafic intrusions extending in a linear zone for approximately 70 km through the Island Lake greenstone belt (Theyer, 1978). Spinifex textures in several bodies indicate local extrusion of the ultramafic rock (Theyer, op. cit.). The margins of these intrusions are locally coincident with the hinge-zones of folds which have been interpreted as faulted (Figs. GS-7-3 and GS-7-4). The serpentinized peridotite is generally medium grained, massive, and characterized by irregular fractures associated with alteration. Magnetite veining occurs locally in the eastern body. The western body is locally contiguous with massive gabbro and hornblendite(8) but the relationship between units 7 and 8 is unknown.

A major gabbro body(8) up to 870 m thick occurs in the southern part of Jubilee Island and two prominent gabbro sills intrude basalt(1) and sedimentary rocks(3) in the vicinity of eastern Confederation Island (Fig. GS-7-3). The gabbro displays a medium- to coarse-grained, massive texture with plagioclase approximately equal to hornblende. Hornblende occurs as elongate prisms (generally 4 mm x 1 mm); no pseudomorphic forms have been observed and the origin (magmatic or metamorphic) is unknown. Classification as gabbro is therefore provisional. The gabbro is locally gradational to hornblendite and, at one locality, serpentinized peridotite. Minor dykes of pegmatitic gabbro and anorthosite occur locally within the intrusions. The gabbro is lithologically similar to some synvolcanic minor intrusions within pillowed basalt(1) but a post-volcanic age is indicated for unit 8 rocks by:

(a) emplacement of some intrusions in sedimentary rocks (3, 4) which overlie the mafic volcanics;
(b) the occurrence of rare basalt xenoliths with slight foliation and felsic veining predating their incorporation; and
(c) the generally massive texture of the gabbro.

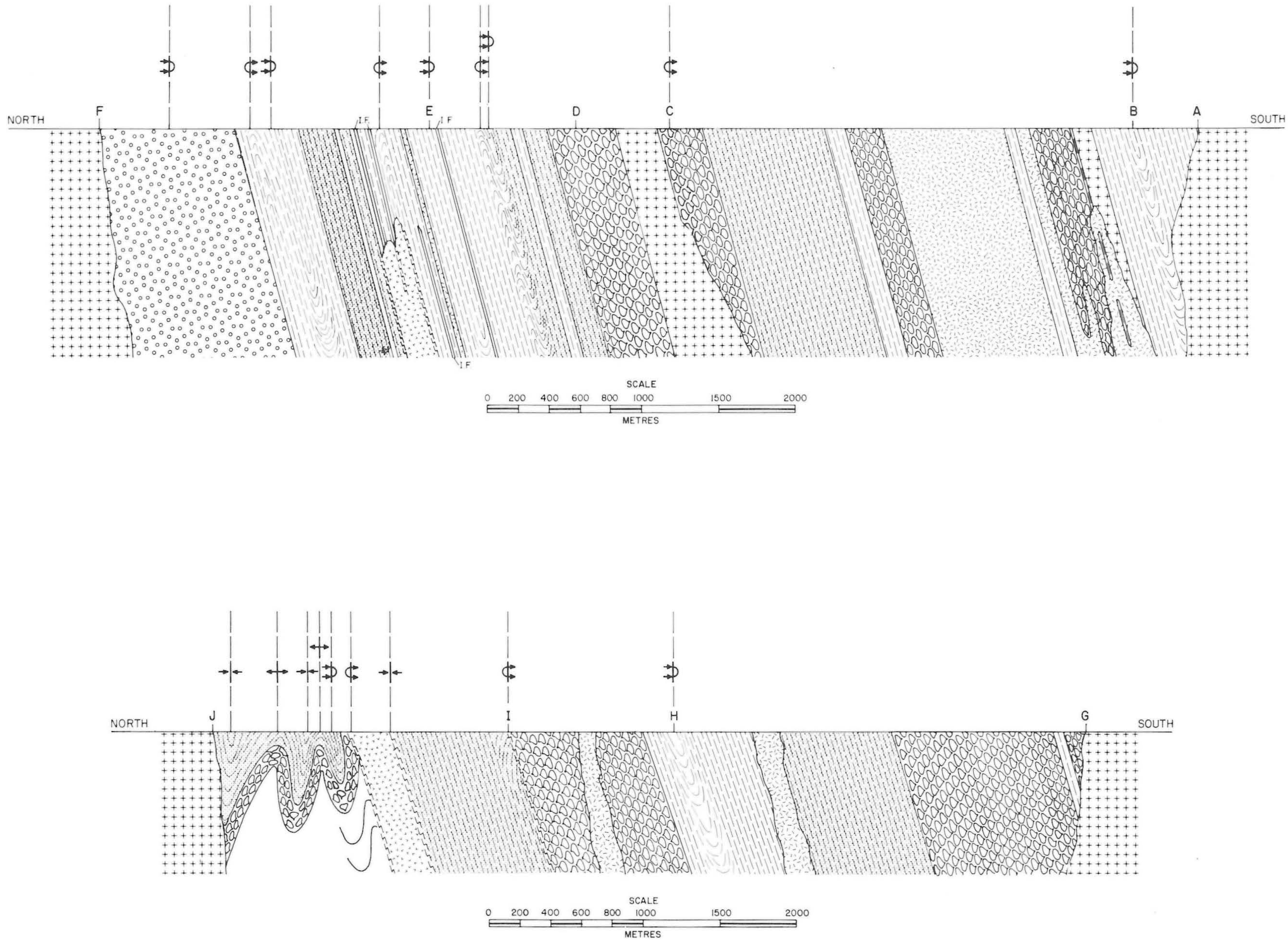

Figure GS-7-4: Cross-sections A-F and G-J, shown in Fig. GS-7-3. Section A-F is from the northwest part of Confederation Island (at south) to the southeast corner of Island Lake Indian Reserve (at north). Section G-J is from Henderson Island (at south) to Meegeesi Bay (at north).

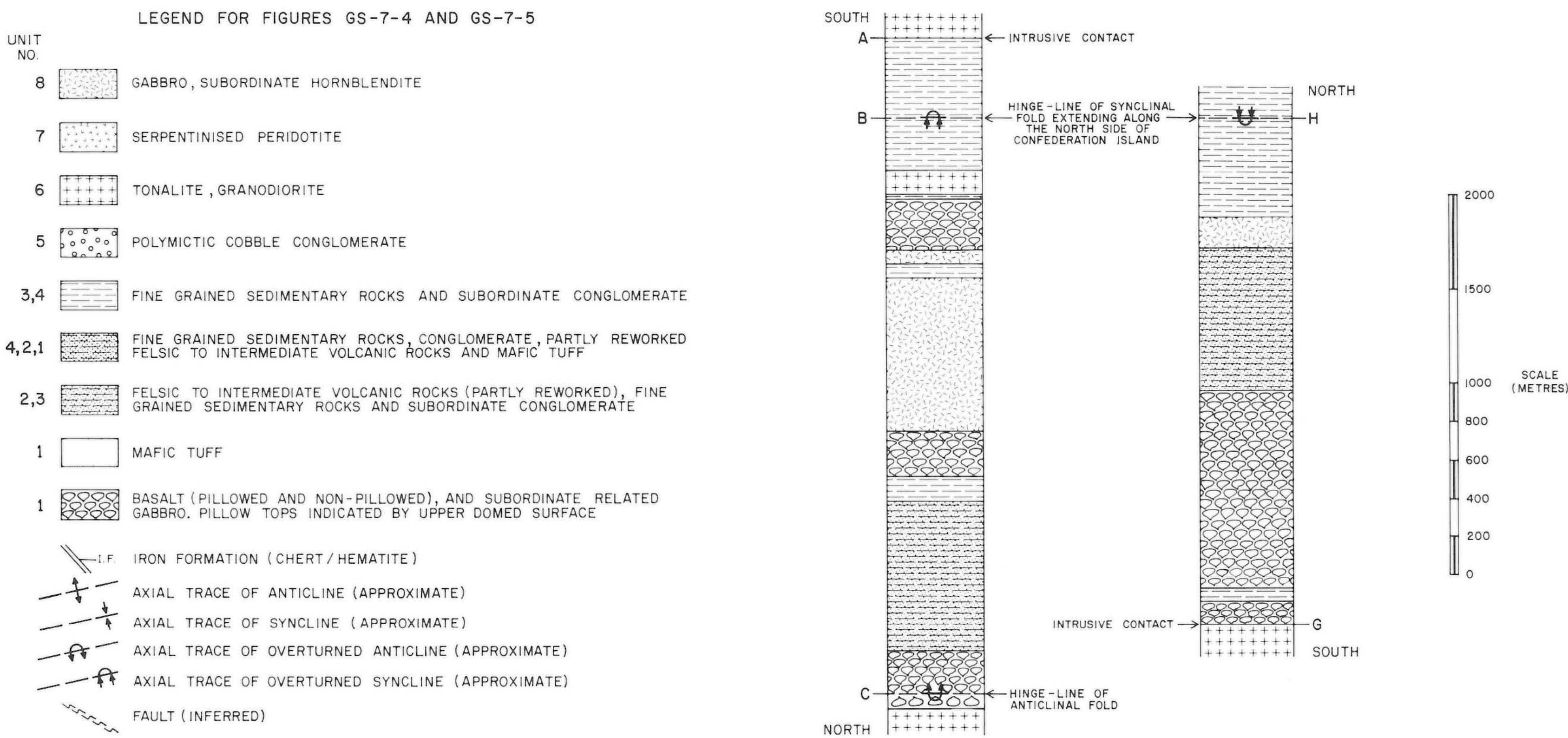

Figure GS-7-5: Stratigraphic sections at Island Lake. Section C-B-A is from the central part of Jubilee Island (at north) to the northwest part of Confederation Island (at south). Section GH is from Henderson Island (at south) to the north side of Confederation Island (at north). Sections are based on apparent thickness (approximately 3% greater than true thickness). The extent of the sedimentary unit close to the base of section GH is uncertain - its thickness is between 70 m and 300 m.

LATE METASEDIMENTARY ROCKS

Polymictic cobble-boulder conglomerate(10) at least 5 m thick occurs in the core of the syncline at the northeast corner of Confederation Island (Fig. GS-7-3). Clast-types include medium grained, massive tonalite and granodiorite (predominant), feldspathic wacke, argillite, quartz, and basalt. The fragments are angular to rounded, ranging from pebbles to boulders (up to 35 cm x 15 cm); the foliated feldspathic wacke matrix comprises 40% to 70% of the rock. Sedimentary fragments are well foliated (pre-depositional) and the base of the conglomerate is scoured into underlying feldspathic wacke and siltstone(3) with truncation of bedding and foliation of the latter. The conglomerate is gradational laterally and vertically with felsic to intermediate feldspathic wacke. The composition and structural relationships of the unit indicate correlation with late metasedimentary rocks(10) at Cochrane Island and the southeast shore of Cochrane Bay (Garden Hill, Preliminary Map 1982I-2). The latter unconformably overlie the Bella Lake pluton, which is the probable source of granitoid clasts in conglomerate of unit 10.

THE EARLY PLUTONIC ROCKS (UNIT 6)

Bella Lake Tonalite (Unit 6a)[1]

The Bella Lake tonalite forms a batholith in the central part of the Island Lake greenstone belt. This summer, the western part of the batholith was mapped.

Rocks of the Bella Lake tonalite(6a) are largely coarse grained and massive to weakly foliated; iron staining is widespread. The plagioclase is almost completely altered to epidote giving the tonalite a distinctive green colour on the fresh surfaces. Fine grained tonalite (unit 6a2) in the southern part of Bella Lake is mineralogically similar to the coarse grained variety. Megacrystic granodiorite (unit 6a1) with orange-pink euhedral microcline megacrysts (up to 5 cm) is a very minor unit. Fine-grained diorite (unit 6a3) is gradational into coarse grained tonalite. It may show weak metamorphic layering at north Bella Lake. A similar more mafic and coarser grained diorite (unit 6a4) occurs further north on the south shore of Cochrane Bay. These diorites probably represent border phases which were contaminated by the mafic country rocks (unit I). Gabbroic amphibolite (1j) is fine- to coarse-grained with plagioclase locally up to 5 cm long. It probably represents an original basalt and gabbro unit which was incorporated into the tonalitic magma, resulting in the present recrystallized texture. The feldspar-rich portions locally tend to separate from the hornblendic aggregates producing very patchy structures. In east Bella Lake, tonalite dykes intrude gabbroic amphibolite (1j). Pink aplite dykes (6g) occur sporadically throughout the Bella Lake tonalite.

The Bella Lake tonalite shows a weak primary foliation (defined by quartz alignment) which trends approximately 240°, varying to 280° north and east of Bella Lake towards gabbroic amphibolite. The contact with Hayes River Group metasedimentary rocks (units 4, 5) in the southern part of the Bella Lake tonalite is sharp and the foliation of the tonalite is oblique to the contact.

Waasagomach Tonalite (6b)

The Waasagomach tonalite is medium grained, slightly more foliated and fresher than the Bella Lake tonalite (i.e., epidote alteration and iron staining are common but less extensive). Hornblende is the dominant mafic mineral, but in the strongly foliated tonalite (unit 6b1) biotite is commonly dominant. Migmatite (6b2) south of St. Theresa Point comprises fine grained intermediate to mafic biotite ± hornblende gneisses with medium grained granitic **lit-par-lit** injections. The injections are variable in thickness and are commonly from 0.5 m to 3 m wide; in some outcrops only the granitic injections, and in other areas only gneisses are exposed. The migmatite unit is strongly foliated.

The primary foliation (quartz alignment) in the Waasagomach tonalite trends 240°. In the northern part the contact with the Hayes River Group rocks is sharp and the foliation in the tonalite is oblique to the trend of the supracrustal rocks. However, in the St. Theresa Point area, the foliation trend of subunit 6b1 conforms with the outline of the migmatite unit. Towards the contact with the Hayes River Group rocks, the tonalite foliation becomes parallel to the contact and the regional foliation of the supracrustal rocks.

Chapin Bay Tonalite (Unit 6c)

The Chapin Bay tonalite forms the northern boundary of the Island Lake greenstone belt. It corresponds to the medium- to coarse-grained, foliated hornblende (± biotite) tonalite to granodiorite mapped in the Molson-Kalliecahoolie Lakes plutonic complex (unit 3a, Weber and Schledewitz, op cit.).

North of Cochrane Island the tonalite is strongly sheared (hornblende is largely recrystallized to biotite) and intersected by mm thin pseudo-tachylite laminae trending 70° - II0°, indicating that this area was affected by several faulting events.

Subhorizontal quartz and feldspar lineations in rocks along the north shore of Cochrane Bay probably represent high structural level B-tectonites, suggesting vertical displacement, related or leading to the east-west folding in the Cochrane Island region.

West of Linklater Island the Chapin Bay tonalite is intruded by granodiorite (unit 6c) and post-tectonic granite (unit 15), equivalent to units 4c and 12, respectively, further north (Weber and Schledewitz, op. cit.). In addition, white leucotonalite dykes and sills and pink mica-free, metasomatic(?) potassium feldspar-rich pegmatites occur in this area.

A band of amphibolite (unit 1i) and tonalite with amphibolite inclusions (unit 6c1i) extends from north of Collins Bay towards Chapin Bay. This zone represents a section of the Island Lake greenstone belt detached as a probable result of subvertical faulting along the northern margin of the belt. Lithological and structural relationships observed northwest of Linklater Island suggest that the major displacement, including the formation of mylonites, preceded the intrusion of granite (unit 15) and that subsequently only minor and very localized cataclastic deformation took place.

The restriction of strongly foliated tonalite clasts to conglomerate of unit 10 along the northern part of Cochrane Bay suggests that deformation along the northern margin of the greenstone belt started shortly after intrusion of the tonalites (unit 6).

GEOLOGY OF THE GARDEN HILL — WAASAGOMACH AREA (53E-15NE/NW), UNITS 5, 9-14, 16

At two locations at Garden Hill, tonalite (unit 6a) intrudes feldspathic wacke (0.4 - 10 cm thick) grading into siltstone (0.2 - 4.0 cm thick) (4d). At both Garden Hill and the northwest shore of Dutile Island, units 4d and 4a are transitional into a clast-supported and typically unstratified pebble-cobble conglomerate (5a). On the southeast shore of Dutile Island, however, the 4a/5a contact is a scoured surface and since subangular sedimentary rip-ups (resembling unit 4 lithologies) are present throughout unit 5a, the numerical (4/5) distinction on Map 1982 I-2 infers erosive channelling synchronous with deposition.

Felsic metavolcanic rocks (9b) are in contact with and may overlie actinolite schist (part of unit 7?) east of Linklater Island. The metavolcanic rocks display aphyric, partly flow-banded zones

[1]Subunits refer to Preliminary Maps 1982 I-1 to 4.

and feldspar- quartz-phyric, partly brecciated (tectonic or autobrecciated) zones. Rounded, lapilli size felsic clasts and quartz fragments (which appear to have been derived from fragmented early quartz veins) are locally abundant in a siliceous, weakly stratified zone near the contact with actinolite schist. These felsic rocks were previously interpreted as quartz-pebble conglomerate (Theyer, 1977, 1978); however, they may represent a (reworked?) ash flow deposit or a brecciated felsic dome with associated talus deposits.

Quartz-feldspar porphyry stocks are closely associated with felsic volcanics (9a to 9e) and intrude mafic breccia (1f) and metagabbro (8).

Matrix-supported regolith (10k), quartz wacke (10a), and clast-supported cobble-pebble and cobble-boulder conglomerates (units 10 l and 10m respectively) overlie unit 6 and form the base of the Late Metasedimentary Rocks (Fig. GS-7-2, units 10, 11). They are not younger than the remainder of the Cochrane Bay sequence, as originally suggested (Neale and Weber, 1981). Units 10k, 10 l and 10m on the south shore of Cochrane Bay are transitional into unit 10q, comprising a clast-supported cobble-pebble conglomerate (25-35 cm thick) grading into sub-feldspathic lithic wacke (35-40 cm thick) on the islands 200 m north of the south shore.

Feldspathic lithic wacke (5-25 cm thick) grading into argillite (2-3 cm thick) (11b) and rhythmically laminated (1-2 cm) argillite and siltstone (11c) lie above the conglomeratic sediments (unit 10). They are not part of the older Hayes River Group metasedimentary rocks (unit 4) as indicated by Godard (1963).

Biotite-tonalite (12a) and quartz diorite (12b) intrude feldspathic green wacke with siltstone interbeds (10h), just south of eastern Cochrane Island. Fine grained tonalite (12c) intrudes unit 10q near the south-central shore of Cochrane Bay. Feldspar porphyry represents a chilled contact phase of unit 12c. Similar feldspar porphyries (sub-units 12d1 to d4) are associated with the quartz diorite (12d) between Linklater and Cochrane Islands (53/15NW), where they intrude sub-feldspathic lithic green wacke (10d).

Chloritic dykes (13c) intrude tonalite (6a) and quartz-feldspar porphyry (9f). Porphyry dykes (14a to e) intrude units 8, 10, 11 and 12. Fine grained diabase (16a) of the Molson Dyke Swarm (Scoates and Macek, 1978) intrudes unit 10 on the south shore of Cochrane Bay.

DEPOSITIONAL ENVIRONMENTS OF UNITS 10 AND 11

The transition from ungraded, cobble-boulder conglomerate (10m) to sharp based and reversely graded cobble-pebble conglomerate (10q) is interpreted as the margin of an alluvial fan entering a river valley. The high matrix content and clast angularity of unit 10p suggests it may be a debris flow. The clast-supported and trough cross-bedded unit 10m is regarded as a distal alluvial fan or proximal braided river deposit. Compared to 10m, clast size decreases and sand content increases in the conglomerates (units 10n, 10o and 10q), typical of a downstream transition. Siltstone with argillite and rare calcareous interbeds (10i) represents overbank deposition. The presence of sediment infilled desiccation cracks supports this interpretation.

On the southeast shore of Cochrane Island there is a change, in continuous outcrop, from sharp based and reversely graded beds of unit 10q to feldspathic lithic wacke containing pebble-granule infilled scours (60 cm wide) (11a). Argillite interbeds (1-3 cm thick), absent from unit 10q, have a sporadic distribution in unit 11a and are increasingly abundant upsection (11b, c).

The thinning- and fining-upward transition from units 11a to 11c is interpreted as a submarine channel fill (mid-fan) to basin plain sequence. Unit 11a is interpreted as a "pebbly sandstone" (Walker and Mutti, 1973) in which stratification is crude and small-scale scouring abundant. In unit 11b, sharp based, normally graded wacke is locally overlain, in turn, by (i) massive wacke, (ii) poorly preserved parallel laminated wacke, (iii) ripple cross-laminated wacke, and (iv) argillite. This sequence is interpreted as ABCE Bouma divisions of classical turbidites, indicating that the beds of unit 11b were deposited close to the source of the turbidity currents (Walker, 1967). The uppermost unit (11c) comprises rhythmic beds of parallel laminated siltstone overlain by argillite; they are interpreted as DE Bouma divisions, suggesting relatively distal desposition.

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GS-8 MINERAL DEPOSIT STUDIES IN THE LYNN LAKE AREA

by M.A.F. Fedikow and G.H. Gale

INTRODUCTION

Concern, triggered by the rapidly dwindling ore reserves in the Lynn Lake district, has led to an intensification of geological and mineral deposit investigations in this region. Since the compilations of mineral occurrences by Milligan (1960), mineral deposit studies have included brief examinations of selected massive sulphide occurrences (Gale and Koo, 1977; Koo, 1976), a study of the geological setting of the Fox Lake Mine (Lustig, 1979) and a detailed study of Ni-Cu bearing gabbroic (ultramafic-mafic) intrusions (Pinsent, 1980). The current program was designed as a first step towards a detailed documentation of the geological setting of all known mineral occurrences and the establishment of the geological controls affecting the deposition of the metals.

Field work was conducted mainly in the immediate vicinity of Frances Lake in the Lynn Lake Rhyolitic Complex and the Agassiz gold-silver deposit, however, several other mineral occurrences were examined (Fig. GS-8-1). Some of these mineral occurrences are known only from drill core and are the focus of current exploration programs. Detailed reports on these occurrences will be presented at a later date.

FRANCES LAKE AREA

Investigations in this area were designed to establish the nature of the known mineralization and related alteration, its stratigraphic position within the Frances Lake felsic rocks, as well as the collection of evidence useful in the determination of the stratigraphic younging direction. The methods used for the determination of the above were: a) examination of drill core, b) detailed mapping of selected outcrop areas, and c) a regional bedrock geochemical sampling program.

The large body of felsic rock centered on Frances Lake consists of massive porphyritic rhyolite, porphyritic rhyolite breccia and rhyolitic tuffs (Gilbert et al., 1980; Fig. GS-8-2). Segments of this body contain bedded pyroclastic rocks consisting mainly of quartz and feldspar-phyric tuffs (D.A. Baldwin, pers. comm., 1982; Table 1) (Fig. GS-8-3). This body of felsic rocks hosts several Zn-Cu sulphide deposits in the immediate vicinity of Lynn Lake (Fig. GS-8-2). Three of the known Zn-Cu deposits, namely, the Nicoba, Y and the Frances Lake deposits, have characteristics of exhalative massive sulphide deposits. These deposits contain stratabound solid sulphide lenses consisting predominantly of pyr-

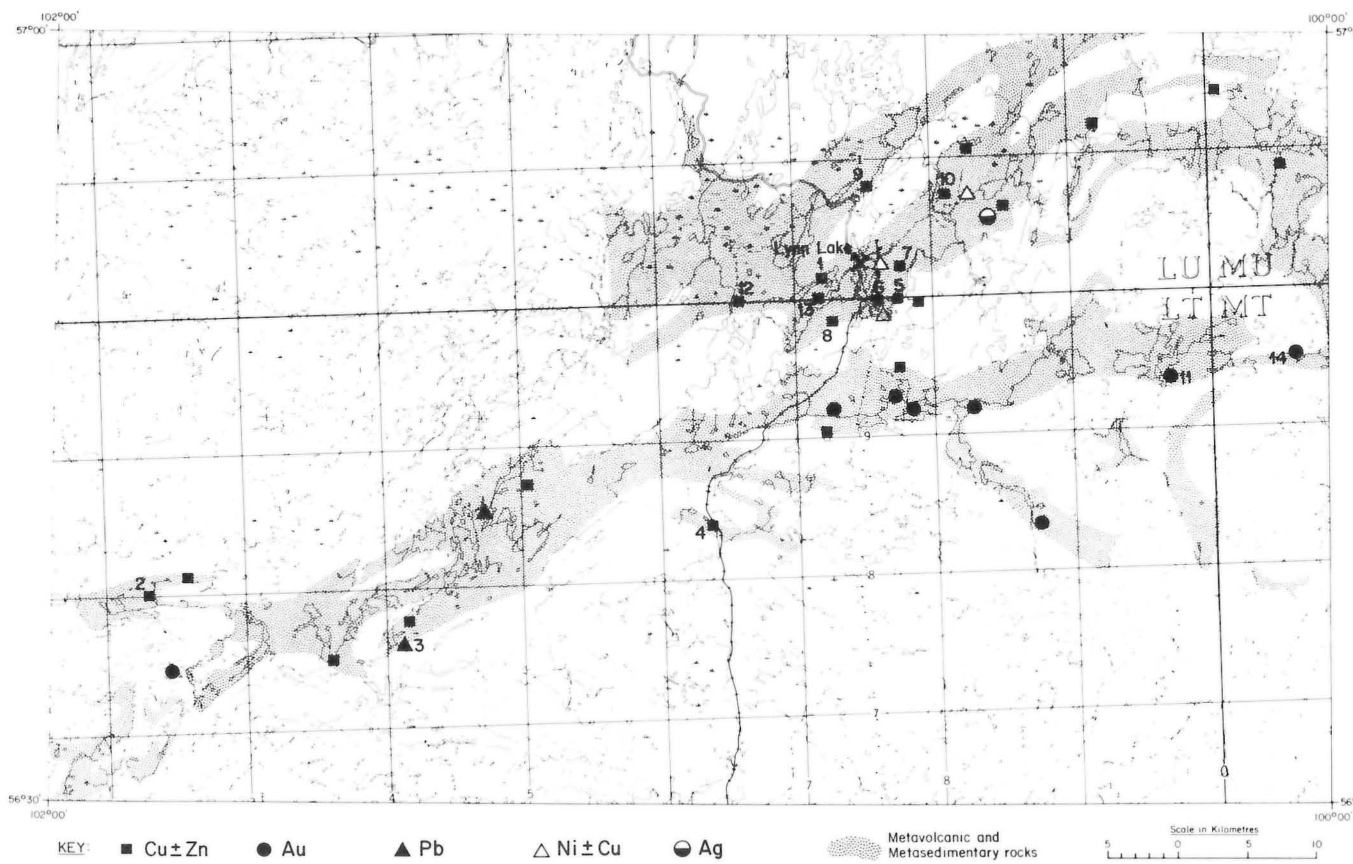

Figure GS-8-1: Metavolcanic and metasedimentary rocks of the Wasekwan Group in the Lynn Lake area. Deposits examined are: 1. Sheila Lake-Margaret Lake occurrence; 2. Lar deposit; 3. Snake Lake occurrence; 4. Boyley Lake occurrence; 5. God's Lake deposit; 6. Z deposit; 7. Y deposit; 8. Nicoba deposit; 9. Sherlynn deposit; 10. Agassiz deposit; 11. Giant deposit; 12. Motriuk Lake occurrence; 13. Frances Lake deposit; 14. Gold Lake occurrence.

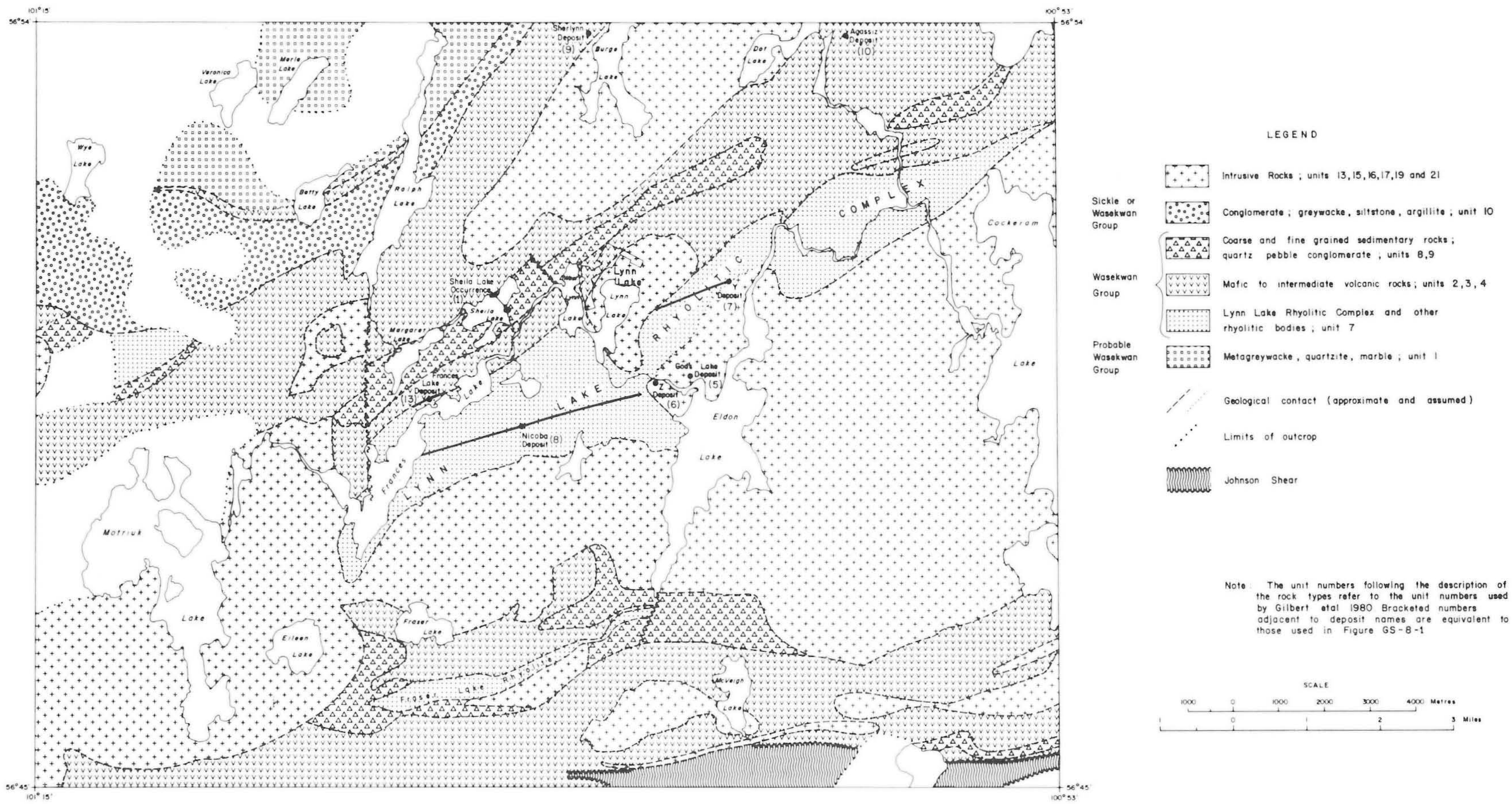

*Figure GS-8-2: Simplified geological map of the Lynn Lake area with the location of mineral deposits and occurrences investigated during 1982. Geology modified from Gilbert **et al.**, 1980.*

TABLE GS-8-1: Lithologies of Felsic Tuff Units in Figure 3.

Unit	TEXTURE	COLOUR		PHENOCRYSTS				METACRYSTS		FRAGMENTS					NOTES
				Plagioclase		Quartz							Phenocrysts		
		Fresh	Weathered	Max. Dia. (mm)	Vol. % (Est.)	Max. Dia. (mm)	Vol. % (Est.)	Boitite	Garnet	Present	Absent	Max. Dia. (cm)	Plag.	Quartz	
1	Fine grained porphyritic fragmental	GREY	BUFF TO LIGHT GREY	3.0	10	1.0	5	X		X		2.0	X	X	Phenocrysts in rock are euhedral, slightly rounded and broken. Phenocrysts in fragments same size as those in matrix. Fragments all have same lithology. Fragments contain fewer phenocrysts than remainder of the rock. Fragments make up approximately 10 per cent of the rock.
2	Fine grained massive porphyritic			3.0	5	2.0	5	X			X				Phenocrysts mainly euhedral, rarely broken. Decrease in phenocryst abundance in upper 10 cm of unit. Upper 2 cm of unit is laminated and biotite-rich.
3	Fine grained porphyritic fragmental			2.0	5	1.0	5	X	X	X		2.0	X	X	See notes for unit 1. Locally quartz phenocrysts are concentrated in layers 1 to 5 cm thick.
4	Fine Grained massive porphyritic			3.0	10	1.0	5	X			X				Phenocrysts are euhedral, slightly rounded and broken. Phenocryst distribution not uniform.
5	Fine grained massive porphyritic			3.0	15	1.0	5	X			X				Phenocrysts are euhedral, slightly rounded and broken. Plagioclase phenocrysts are white and pink.
6	Fine grained massive porphyritic			1.0	5	0.5	5	X			X				Apparent abundance grading of phenocrysts. Phenocrysts mainly euhedral.
7	Fine grained porphyritic fragmental			3.0	10	1.0	5	X	X	X	X	2.0	X	X	See notes for unit 1. Distribution of fragments irregular. Concentration of fragments in layers up to 30 cm thick.
8	Fine grained massive porphyritic			3.0	10	1.0	5	X			X				Phenocrysts are mainly euhedral and are graded in both size and abundance in upper 25 to 30 cm of unit. Contact between unit 8 and 9 is sharp.
9	Fine grained massive porphyritic			3.0	10	1.0	5	X			X				Phenocrysts mainly euhedral, crystal aggregates common.

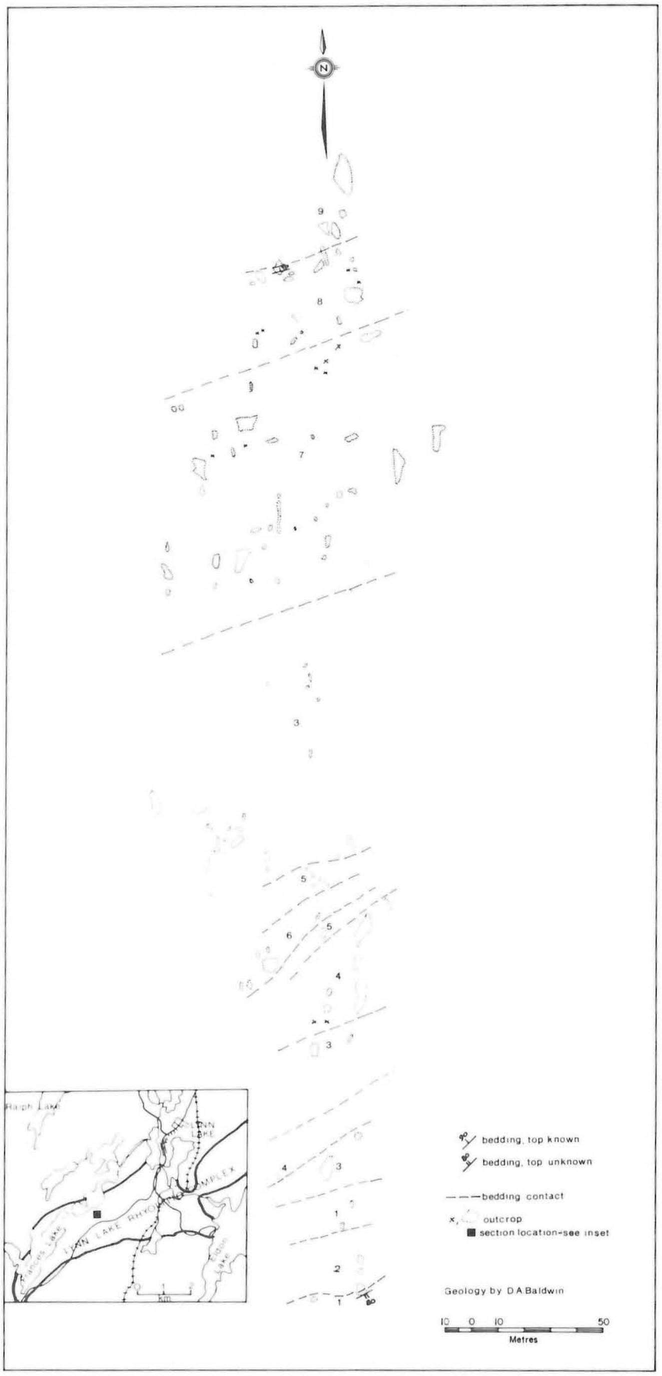

Figure GS-8-3: Outcrop map and geology of part of the Lynn Lake Rhyolitic Complex as exposed in a gravel pit near Frances Lake.

ite and pyrrhotite with subordinate amounts of sphalerite, chalcopyrite and galena. The relative abundances of the metals in the solid sulphide lenses is zinc greater than copper greater than lead.

The Nicoba deposit is immediately underlain to the south by an extensive area of altered rocks in which distinct and overlapping zones of alteration contain the mineral assemblages kyanite-sericite-cordierite- biotite-quartz; garnet-chlorite; and quartz-sericite. The Y deposit is underlain by a narrow cross-cutting zone of sericitic alteration. The paucity of exposures in the vicinity of the Frances Lake deposit precludes the identification of an alteration zone by surface mapping. The Y deposit differs from the other two in that it is overlain by a zinc-rich layer of exhalative and detrital sedimentary rocks that can be used to define the stratigraphic position of the mineralization for several km. This unit of sedimentary rocks locally contains abundant gahnite ($ZnAl_2O_4$).

The God's Lake (Milligan, 1960) and Z zinc-copper deposits (Fig. GS-8-2) are contained within intrusive rocks. Surface exposures in the vicinity of the Z deposit (Fig. (GS-8-4) consist of gabbroic and dioritic rocks. The God's Lake deposit is located beneath a swamp and is only known from drill core. Examination of drill core from the Z and God's Lake deposits indicates that mineralization in both deposits occurs as a network of solid sulphide veins, the majority of which are a few cm to several tens of cm in thickness. These sulphide sections are commonly associated with chloritic schists and fine grained mafic rocks, of probable volcanic origin, that rarely exceed several tens of cm in thickness. The chloritic schists appear to have developed from the volcanic and dioritic rocks after emplacement of the sulphides. The mineralization is herein interpreted to represent mobilization of zinc-copper bearing sulphides into the consolidated intrusion in response to a metamorphic event. These sulphides, presumably derived from an adjacent exhalative massive sulphide deposit, proceeded into the intrusion along fractures. It is also feasible that these deposits represent xenoliths of an exhalative massive sulphide deposit since fragments of the mafic and the silicic volcanic country rocks are also present elsewhere in the intrusion.

Cross-cutting metamorphosed alteration products have been identified at apparently the same stratigraphic level extending from Frances Lake east to the immediate area of the Z deposit (Fig. GS-8-2).

In the vicinity of the old dump area (Fig. GS-8-5) an extensive zone of garnet-chlorite alteration with minor sulphide and trace gahnite have been identified. To date no solid sulphide lenses have been identified in association with this zone of altered rocks.

A bedrock geochemical sampling program was undertaken to characterize the chemical signature of the alteration identified at Nicoba and the old dump site as well as to determine if other areas of altered rocks are present in the Lynn Lake Rhyolitic Complex. A total of 225 samples were collected from the Lynn Lake Rhyolitic Complex for this alteration study (Fig. GS-8-6).

SHERLYNN DEPOSIT

The immediate vicinity of the Sherlynn sulphide occurrence (Fig. GS-8-1) was mapped. Selected drill core from the deposit were logged to establish the nature and types of alteration and mineralization present. The general geology of the area is shown in Figure GS-8-7 and only briefly described here, since it will form the basis of an Honours Bachelor of Science dissertation by W. Mandziuk, University of Manitoba.

The Sherlynn deposit occurs in chloritic schists adjacent to the contact with a large granodioritic intrusion. Graded beds within mafic volcanogenic sedimentary rocks and tuffs indicate that the stratigraphic top of the rocks north of the occurrence is towards the northwest.

The sequence from south to north includes: chloritic schists + sulphide veinlets; mafic volcanic rocks + narrow chloritic schist sections; mafic volcanic rocks + dykes of granodioritic rocks; a thick unit of polymictic (predominantly basaltic) fragments within a mafic flow rock and mafic volcanogenic sedimentary rocks. A thin unit of silicic volcanic rocks, of probable dacitic composition, occurs stratigraphically below the unit of mafic volcanogenic sedimentary rocks. A rock unit identified as a pyroxene crystal tuffite occurs within the mafic volcanogenic sedimentary rocks.

The Sherlynn sulphide deposit is a complex zinc-copper deposit consisting predominantly of sulphide veinlets (pyrrhotite, pyrite, chalcopyrite and sphalerite) in a chlorite $\pm$ biotite schist that commonly contains more than 80% chlorite and/or biotite adjacent to the sulphides. The coarse grained schists were derived from the mafic volcanic host rocks prior to the regional metamorphism. A weak alteration, reflected by the development of fine grained green chlorite (Fe-rich?) overprints the regional metamorphism. This later chlorite develops primarily along microfractures and is attributed to a thermal event accompanying intrusion of the granitic rocks.

The mineral assemblages produced during metamorphism of the early alteration event are biotite, chlorite and sericite. This mineral assemblage is typical of metamorphosed altered mafic rocks hosting exhalative massive sulphide deposits. The presence of disseminated and stringer pyrite north of the Sherlynn deposit indicates that the hydrothermal activity producing the Sherlynn deposit may also have resulted in the deposition of sulphide mineralization at a higher stratigraphic level, i.e. northwest of the Sherlynn deposit. The Sherlynn deposit may be the alteration zone or feeder zone to a stratigraphically higher massive sulphide deposit.

THE AGASSIZ GOLD-SILVER DEPOSIT

The Agassiz Au-Ag deposit is located 8 km northeast of the town of Lynn Lake (Fig. GS-8-1) at Latitude 56°53′30″ and Longitude 100°57′00″. The deposit occurs in a northeast-trending belt of intermediate to mafic volcanic rocks of the Wasekwan Group. The immediate host rocks for the mineralization are fine grained tuffaceous, clastic and chemical sedimentary rocks and altered tholeiitic basalts. Results from the Questor (1976) geophysical surveys indicate the deposit has a distinct geophysical signature and places the mineraliztion on the north flank of an aeromagnetic high within a formational INPUT conductor. To date, a mineralized zone containing approximately 1.6 million tons of 0.147 oz/ton Au and 0.25 /ton Ag has been outlined (J. Chornoby, pers. comm., 1982).

A program of detailed geological mapping and regional and detailed geochemical sampling utilizing both outcrop and diamond drill core was initiated in the host rocks of the Agassiz deposit during the 1982 field season. The purpose of these studies is to determine the geological setting, nature, and extent of geochemical alteration halos associated with the mineralization and thereby generate a working model for ore genesis that might aid the search for Agassiz-type gold-silver mineralization in the Lynn Lake area. Preliminary observations and interpretations are presented here.

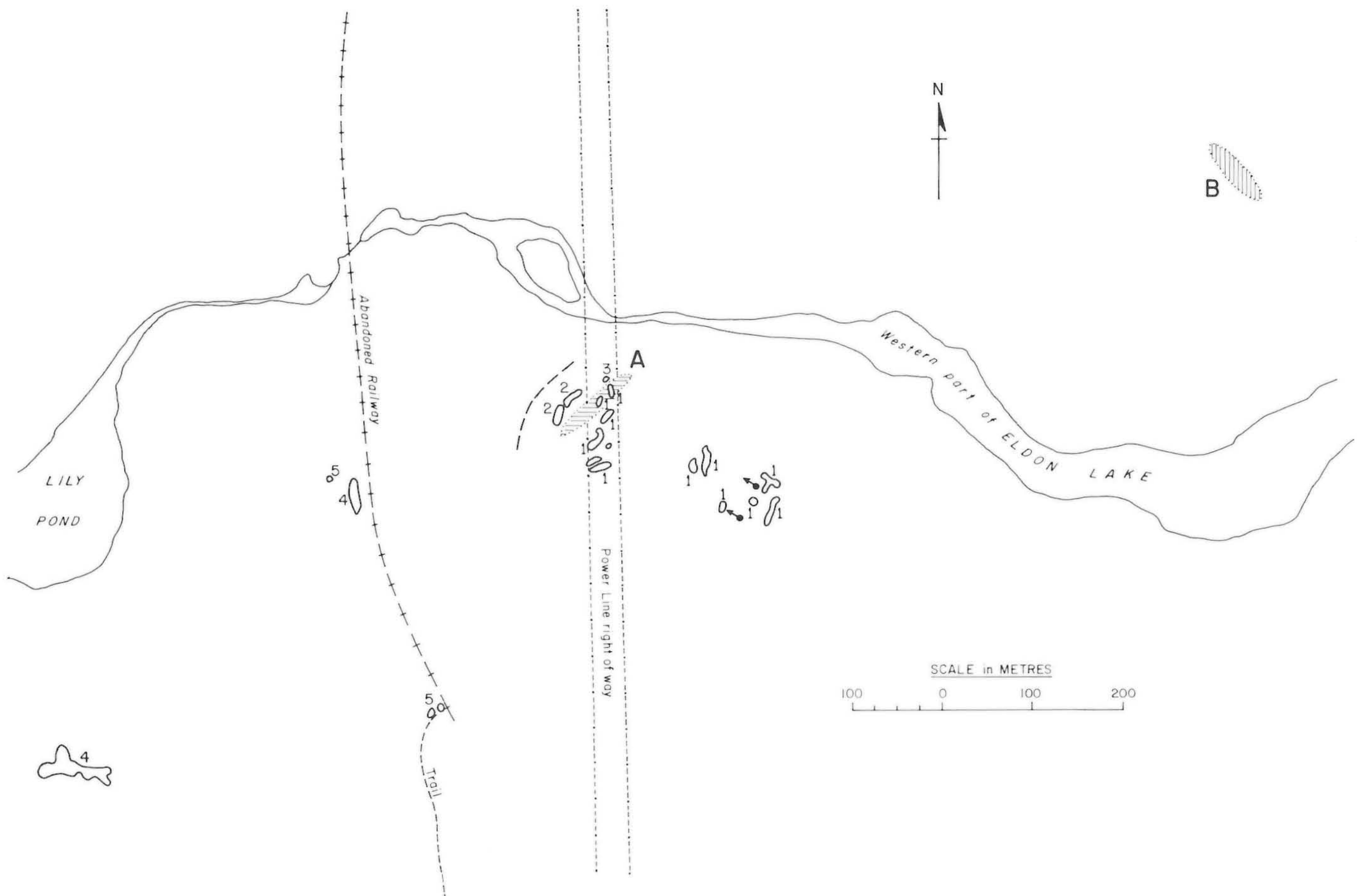

Figure GS-8-4: Geology of the area around the Z deposit, Lynn Lake; 1. medium grained, leucocratic, hornblende-bearing gabbroic rocks; 2. dark green amphibolitic rocks; 3. silicic volcanic rock xenolith in unit 1; 4. frost-heaved rhyolitic rocks with 1-10% pyrite; 5. rhyolitic pyroclastic rocks with minor chlorite. A. Approximate postion of Z deposit. B. Approximate position of God's Lake deposit. Arrow indicates old diamond drill hole. Broken line represents approximate position of intrusive contact.

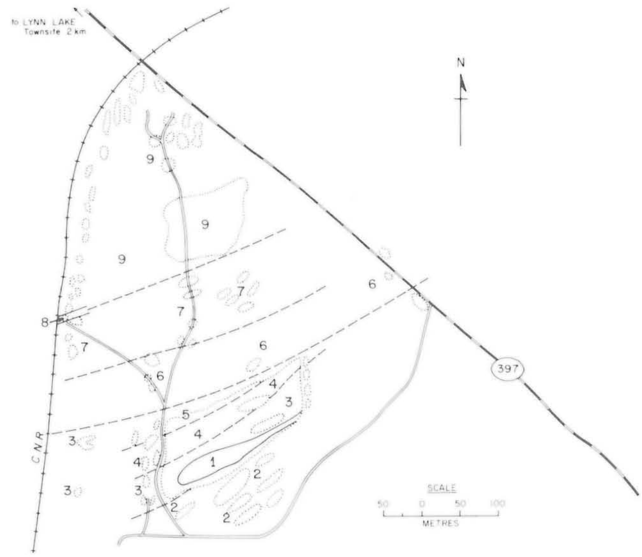

Figure GS-8-5: *Geology of the Old Dump site, Lynn Lake area: 1. medium grained massive dacite; 2. rhyodacitic pyroclastic rocks with minor pyrite; 3. silicic pyroclastic rocks with minor garnet and chlorite alteration; 4. silicic pyroclastic rocks with up to 2 cm fragments and intense garnet and chlorite alteration; 5. garnet-chlorite and cordierite alteration; 6. rhyolitic pyroclastic rocks; 7. quartz and feldspar-phyric rhyolitic rocks; 8. pyritic and silicic fragmental layers; 9. rhyodacitic rocks; includes quartz and feldspar-phyric massive and schistose rocks of probable pyroclastic origin; in part rusty weathering due to minor pyrite.*

Geology of the Agassiz deposit

The immediate host rocks for the Agassiz deposit form part of the Keewatin River Supracrustal Belt of the Wasekwan Group. The belt is exposed between Motriuk Lake and Eagle Lake east of the Keewatin River and consists of intermediate and mafic volcanic flows and tuffs, dacite and greywacke-siltstone. The details of stratigraphy, structure and descriptions of the individual units are given by Gilbert at al., 1980. The following geological descriptions are concerned solely with the immediate host rocks to the deposit. A schematic cross-section of the Agassiz deposit illustrating geology and mineralization is presented in Figure GS-8-8.

The rock stratigraphically underlying the mineralization is a green, soft, actinolite-chlorite schist. Outside of the immediate mine area these rocks are characterized by interlocking equant ferroactinolite grains in a carbonate + opaques + plagioclase matrix whereas the highly altered picritic rocks in proximity to the mineralization are porphyroblastic with hornblende megacrysts in a coarse chloritic matrix + carbonate and talc (Fox and Johnston, 1981). Examination of this unit along its exposed strike length indicates that it retains the distinctive actinolite-rich mineralogy.

A sedimentary unit contains the majority of the sulphide mineralization including the gold and silver in the deposit. It comprises a unit of tuffaceous, clastic and chemically precipitated sedimentary rocks. This unit has been particularly affected by a penetrative deformation that produced a foliation (N65°E) that regionally is parallel to layering. This foliation is more pronounced in the sedimentary unit than in the immediately overlying and underlying rocks and probably reflects differences in competence of the original rocks. The deformation and metamorphism have obliterated most of the original textures in the rock, however, possible graded bedding in the tuffaceous portion of this unit and the occurrence of a banded chert-magnetite layer associated with the sulphide mineralization provides a tenuous indicator of a stratigraphic younging to the north. This unit was observed to attain a maximum thickness of 10-15 m and to have a characteristic brown hue due to the biotite content of the rock. Locally, the sedimentary unit contains 2-3 cm elongate felsic fragments, discontinuous 5-10 mm thick iron-stained carbonate bands, biotite-rich patches associated with 1-5 mm red-brown garnets ± sulphide cores, and intercalations of dark green to black amphibole-rich layers. Minor, 5-10 mm thick, discontinuous pink manganese carbonate bands are also present. The sedimentary unit together with the stratigraphically overlying and underlying rocks has a known strike length of approximately 1500 metres.

The hangingwall unit is characterized by amygdaloidal, porphyritic and fragment bearing altered basalts. These rocks have been called amygdaloidal and agglomeratic tholeiitic basalt by Fox and Johnston (1981). The fragments in these rocks are moderately sorted, angular to rounded and slightly elongate with maximum dimensions of 30 cm x 30 cm and contain feldspar phenocrysts and quartz-filled amygdales. Locally the fragments have been partially and/or totally epidotized and are marked by faint boundaries with the matrix. The hangingwall unit is visually altered in the immediate vicinity of the deposit with intense iron-staining and barely discernible fragment outlines. The matrix is a dark green-black mafic rock marked by a lower concentration of phenocrysts and/or amygdales. The hangingwall rocks may also be massive, non-fragmental, siliceous and light grey-green in colour, probably reflecting a siliceous alteration.

The sulphide mineralization in the Agassiz deposit occurs in a number of forms within the sedimentary unit. The sulphides were observed as:

1. thin 1-5 mm monomineralic Py or Po laminae interbedded with biotite-rich sedimentary layers;
2. solid sulphide layers up to 0.5 m thick with pyrite, pyrrhotite, arsenopyrite, sphalerite and minor chalcopyrite and galena;
3. 20-60% disseminated sulphides over 3-5 m with some solid sulphide sections; 60% disseminated sulphide zones are restricted to 0.75 m or less;
4. disseminations, cavity fillings and veinlets in quartz-rich layers (quartz veins?);
5. 1-3% disseminated pyrite and pyrrhotite + arsenopyrite throughout the sedimentary unit.

Mineralization, locally with specks of visible gold in the altered tholeiitic basaltic rocks, occurs as 3-15% disseminated sulphides characterized by pyrite, pyrrhotite and arsenopyrite. Gold in the deposit is erratically distributed throughout the mineralized zones as micron-sized particles, often at the boundaries of sulphide grains (B. Carpick, pers. comm., 1982). Assay results indicate that the best gold grades are obtained when galena and/or arsenopyrite are present. Cherty sedimentary rocks (exhalites or silicification?) in the sedimentary unit commonly contain 0.1 oz/ton gold.

The mineralized zones are terminated by a feature known as the North Shear, a shear zone comprised of multi-directional shears that may be serpentinized and carbonatized. As a result, the shear is not considered to be of major metallogenetic significance in the emplacement of the bulk of the sulphide mineralization but may be related, in part, to secondary mobilization processes responsible for gold enrichment.

Four types of visible alteration were noted in the host rocks of the Agassiz deposit. These occur either in discrete or overlapping zones. Generally, each alteration type has an affinity for a specific geologic environment and rock type within the deposit. The alteration types and their characteristics are listed below.

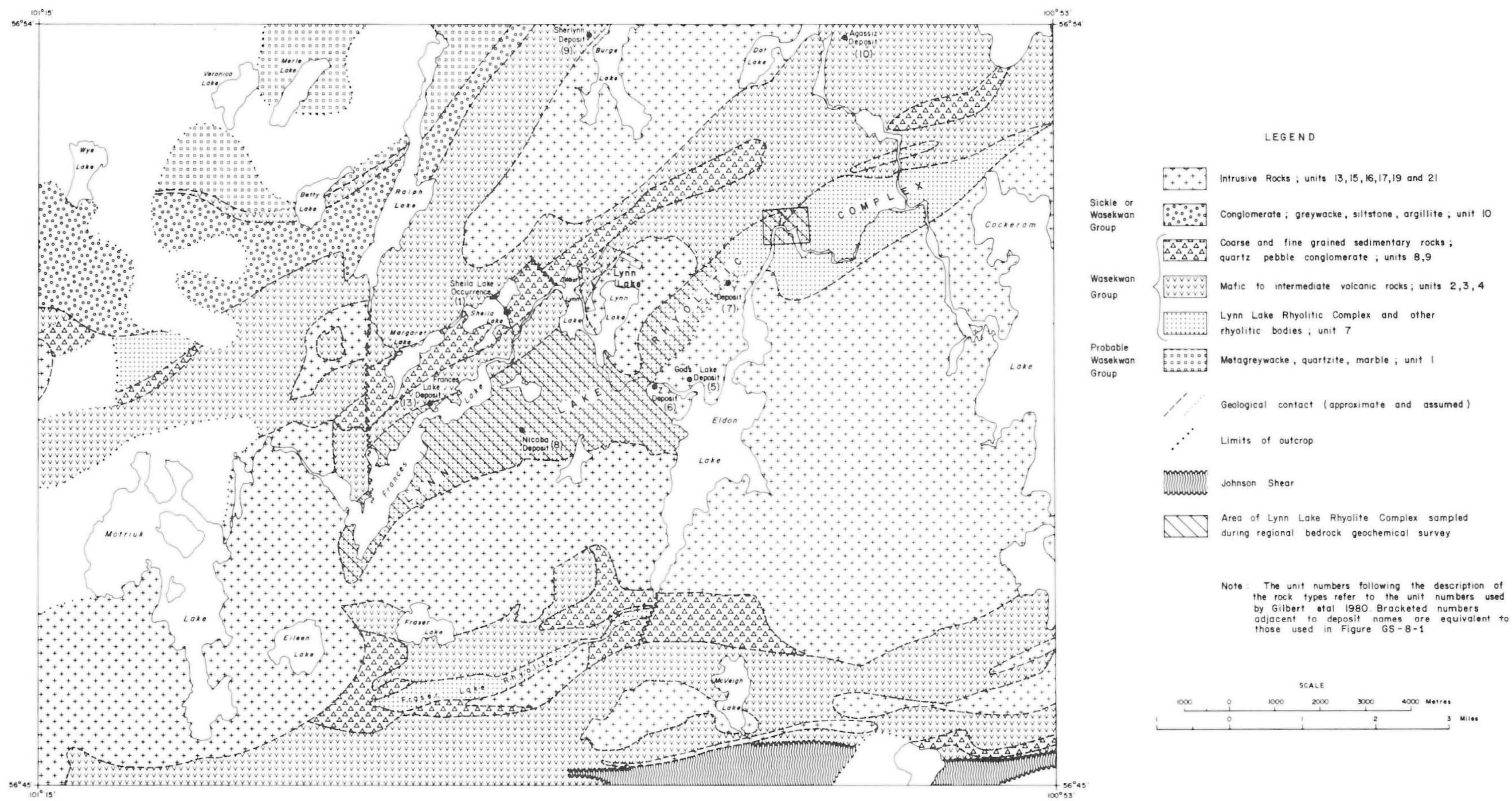

*Figure GS-8-6: Portions of the Lynn Lake Rhyolitic Complex sampled during the regional bedrock geochemical survey. Simplified geology based on Gilbert **et al.**, 1980.*

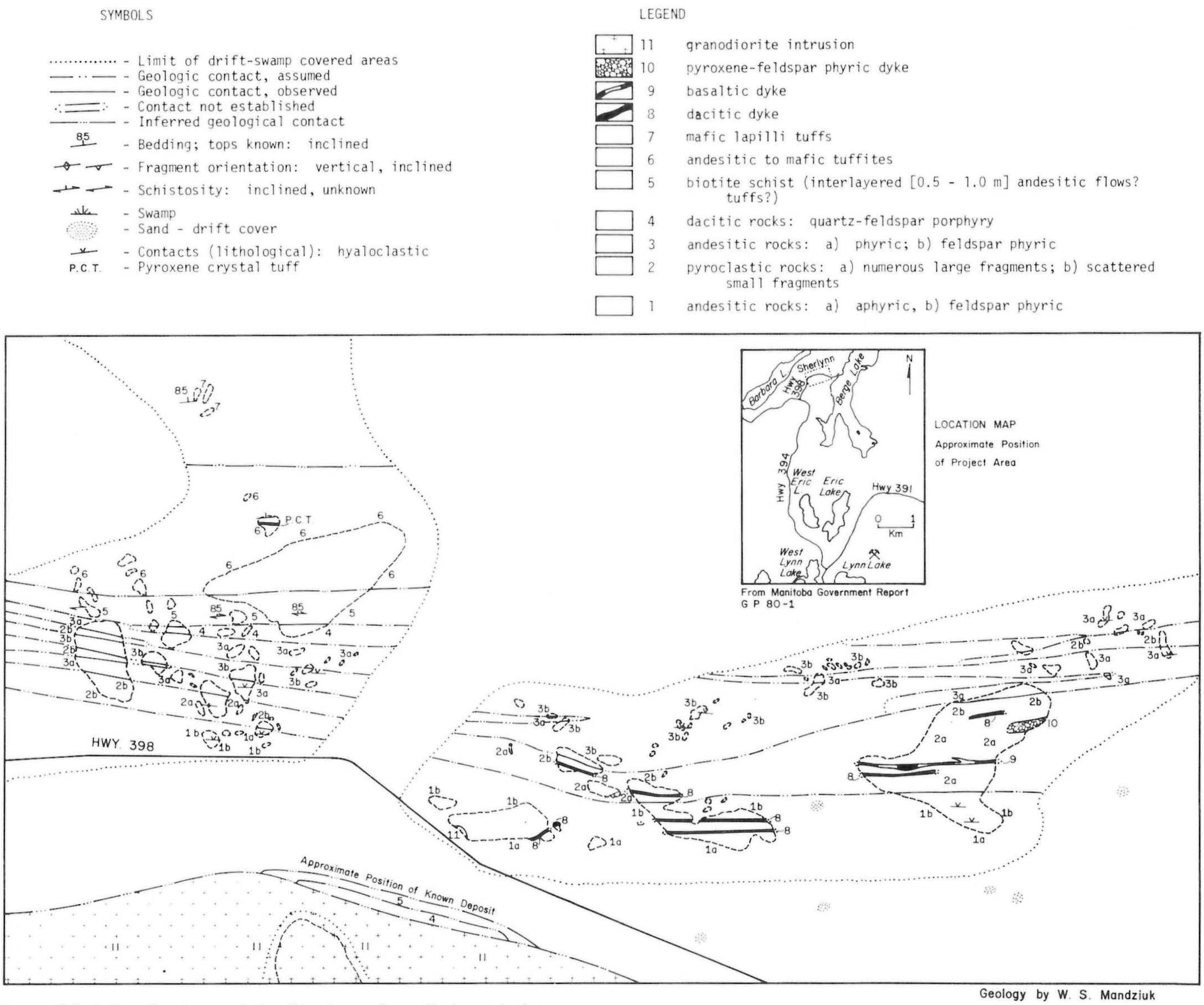

Figure GS-8-7: Geology of the Sherlynn deposit, Lynn Lake.

Alteration type	**Nature of Occurrence**
Carbonatization	Altered basalts and as shear coatings; as patches, veinlets and disseminations with quartz.
Silicification	Sedimentary unit and hangingwall basalts; as diffuse fronts emanating from shear zones.
Chloritization	Generally restricted to shears except in footwall actinolite-chlorite unit.
Biotitization	As 2-3 cm bands of secondary biotite in the sedimentary unit.

Finely disseminated arsenopyrite along with pyrite, pyrrhotite and minor chalcopyrite appear to have an affinity for the silicified zones.

A total of 414 rock samples were collected from surface outcrop and diamond drill core in and around the Agassiz deposit. This study is designed to determine if primary dispersion patterns of major and trace elements occur in the host rocks of the deposit and whether these geochemical halos define an alteration pipe. It may be possible to establish a suite of elements diagnostic of the Agassiz alteration that can then be applied in a regional rock geochemical survey to outline chemically anomalous zones associated with Agassiz-type mineralization elsewhere in the belt.

Figure GS-8-9 illustrates the locations of the diamond drill holes and the surface outcrop samples collected for this study. In order to sample whaleback-type outcrops a portable sampling drill was used to obtain five cores per sampling site. Each core was approximately 7 cm in length. The five cores will be crushed, pulverized and combined after a representative sample has been saved for future thin section and microprobe studies. The samples will undergo multi-element geochemical analysis and results will be reported at a later date.

The Agassiz gold-silver deposit is a stratabound deposit with close genetic affinities to mafic sedimentary and volcanic rocks. The deposit appears to have a number of characteristics that are more consistent with exhalative-type mineralization rather than a gold-bearing vein system. Observations to support this hypothesis are:

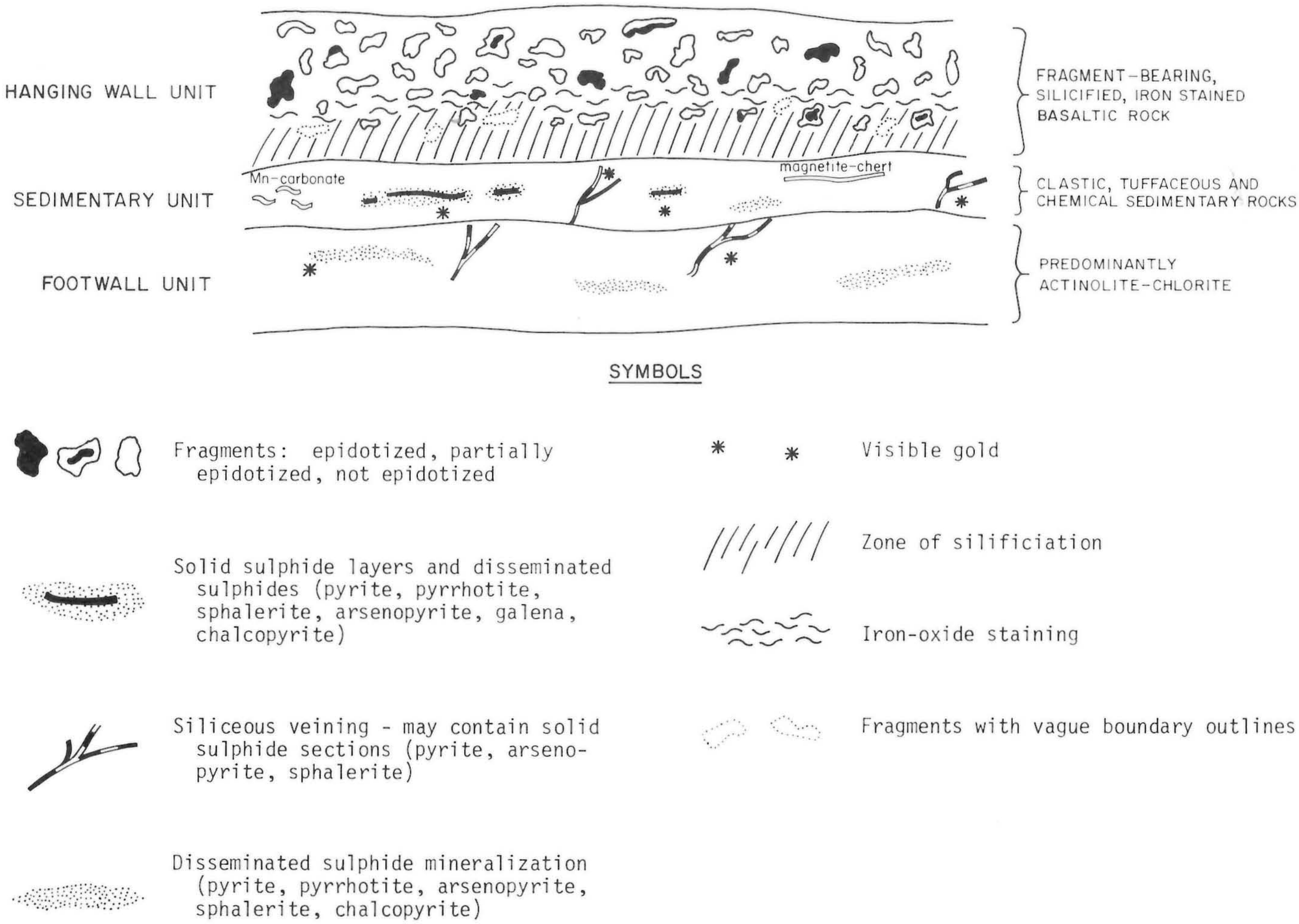

Figure GS-8-8: A schematic cross-section of the geology at the Agassiz Au-Ag deposit illustrating the styles of mineralization and relationship to the host rocks.

1. restriction of most of the sulphide mineralization to one stratigraphic unit;
2. stratigraphically underlying rocks exhibit the most intense alteration;
3. zones of silicification and/or quartz veining probably represent a discordant stockwork or feeder zone that has been flattened or rotated into crude alignment with the mineralized zone by the deformational event producing the foliation in the rocks. The absence of a massive sulphide lens in the Agassiz deposit could be due to either a) an insuffient time break in active volcanism to allow significant thicknesses of sediment and sulphide minerals to be deposited, or b) the down-slope wasting of exhaled mineralizing fluids resulting in sparse Zn-Pb mineralization.
4. The lack of a copper-rich zone and the presence of manganese carbonate is suggestive of a distal-type exhalative mineral deposit.

OTHER ACTIVITIES

A number of other mineral occurrences were briefly examined (Fig. GS-8-1). These include: (1) gold occurrences on the Giant claims (Milligan, 1960) at the south end of Cartwright Lake within the Johnson shear; (2) several drill holes from the Lar massive sulphide deposit on Laurie Lake; (3) surface exposures of altered rocks in the Boyley Lake area; (4) mineral occurrences near Gold Lake and Sheila and Margaret Lake were mapped in detail; (5) diamond drill core from the God's Lake deposit was retrieved from the bush and re-boxed.

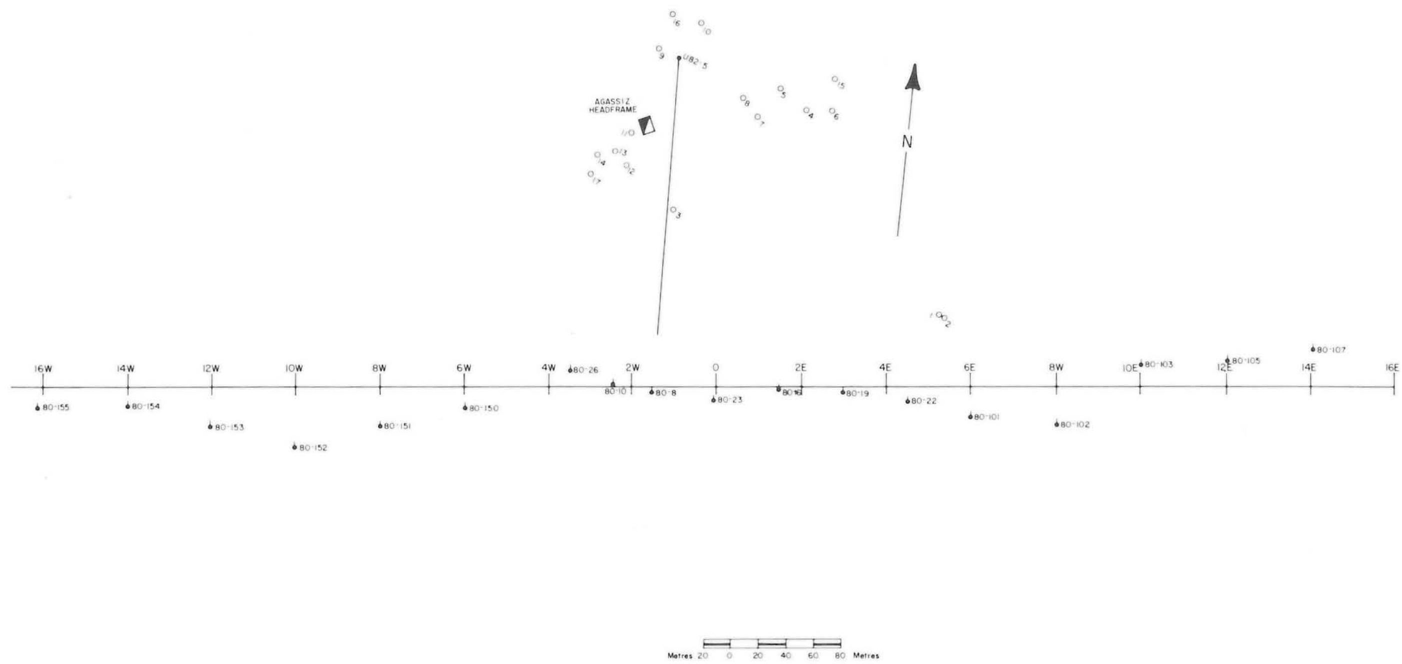

Figure GS-8-9: Location of diamond drill holes and outcrop samples from the vicinity of the Agassiz deposit that were collected for geochemical alteration studies.

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ASSEAN LAKE

An occurrence of gold mineralization on a small island in Assean Lake near the Dunbrack showing (Dawson, 1941) was examined. Visible gold occurs in association with trace to minor amounts of sphalerite, chalcopyrite, galena and pyrite within psammitic and psammopelitic rocks. Discontinuous quartz veins, up to 20 cm thick, are present in the psammitic rocks. The psammitic rocks are underlain by quartz-rich greywacke of the Burntwood Metamorphic Suite and overlain to the northeast by thinly bedded to massive amphibolites that are in turn overlain by quartzofeldspathic (arkosic) sedimentary rocks. This occurrence may have been derived from sedimentary rocks containing minor amounts of gold and base metals as a result of exhalative activity. Subsequent enrichment resulted from shearing and mobilization associated with the Assean Lake Mylonite Zone (Dawson, 1941; Haugh, 1969). This occurrence is considered to be an example of stratabound gold mineralization and occurs in a geological setting similar to that of the stratabound gold occurrences on Nokomis Lake and Puffy Lake in the Sherridon area.

GS-9 MINERAL DEPOSIT INVESTIGATIONS — SUPERIOR PROVINCE

I) Island Lake area II) Bird River Sill (Southeastern Manitoba)

by P. Theyer

Field activities in 1982 were concentrated in two main areas — Island Lake and Bird River Sill. Programs undertaken include:

a) In the Island Lake area; geological investigations and documentation of mineral occurrences and the completion of a geological grid sampling program.
b) In the Bird River Sill area; channel sampling across the entire thickness of the sill for Platinum Group Minerals (P.G.M.) analysis

In addition, one week was spent in God's Lake on a geological reconnaissance program in preparation for the 1983 field season.

I) ISLAND LAKE

A program designed to document major mineral occurrences in the Island Lake area was completed. Results of this work will be prepared for publication in the near future. Several of the gold occurrences examined are considered to be genetically related. These occur in a mineralized zone extending from the Zolota occurrence on the southeastern tip of Okay Island to "Reahil" Island in the east (Figs. GS-9-1 and GS-9-2).

The mafic host rocks are characterized by a 100-150 m wide silicification halo. The core of this halo consists of a sulphide-bearing quartz vein. Sulphide contents have been estimated visually to range from 1-25%. Assay values from selected grab samples range upto 3.78 oz/ton gold (Fig. GS-9-2).

A typical exposure can be found on the shore of a small island ("Alteration Island") (Fig. GS-9-2). At this locality, the silicified mafic volcanic rocks resemble chert. Parts of the outcrop contain steeply dipping quartz-filled fissures. A subhorizontal fissure system gives the outcrop a blocky appearance. These subhorizontal fissures are partially healed by botryoidal beige coloured stalactitic and stalagmitic growths of feldspathic composition (albite?). Circular patches (maximum diameter 20 cm) filled with greenish cherty quartz are interpreted as cross-sections of fluid channels. Chert layers (maximum thickness of 1 m) also occur in this volcanic sequence. Mineralized quartz veins in this specific location are 1 to 15 cm thick and contain sporadic sulphide nodules in which pyrite, pyrrhotite, chalcopyrite, galena and arsenopyrite were identified.

Rock sampling in a grid pattern was completed in four separate areas underlain by rock units that are considered to have a high potential to contain stratabound gold deposits (Theyer, 1981). These areas are shown on Figure GS-9-1: the Western, Linklater, Central and Eastern grids. Samples will be assayed for gold and pathfinder elements that may be present in the alteration haloes.

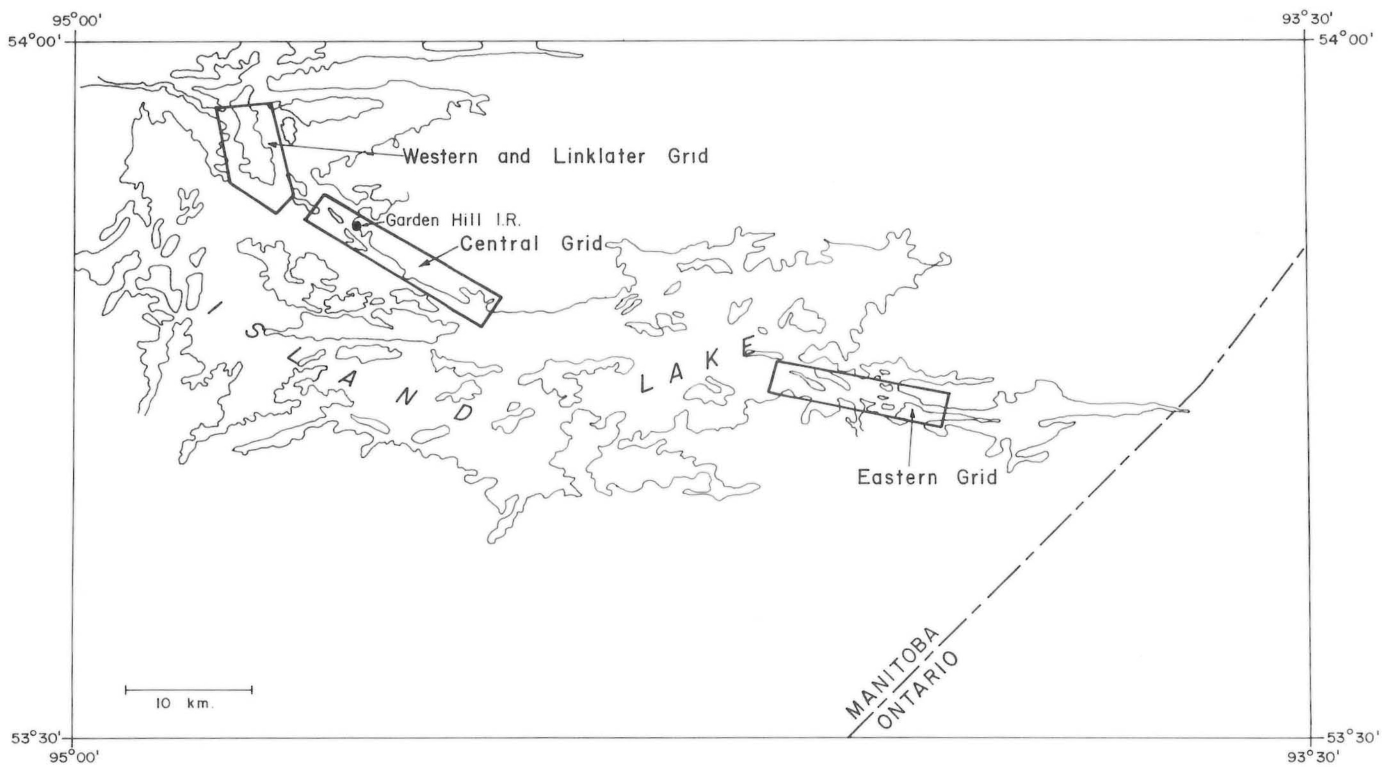

Figure GS-9-1: Location of geochemical sampling grids, Island Lake area.

II) BIRD RIVER SILL (SOUTHEASTERN MANITOBA) — PLATINUM GROUP MINERALS PROJECT

The Bird River Sill (B.R.S.), a large tabular, layered mafic to ultramafic intrusion, is considered to be a potential source of Platinum Group Minerals (P.G.M.) as well as chromite (see report GS-11, this volume).

Fire assaying of samples from the chromitite layers was initiated in 1981 (Theyer, 1981). One sample from the Chrome area (Fig. GS-9-3) yielded 1.6 ppm Pt ; however, this value was not reproduced in follow-up assays of the same sample.

P.G.M. inclusions were found in chromite from the Chrome area using a microprobe (Talkington **et al.** (in press)). They conclude that P.G.M. occur only in the chromite crystals of chromitite seams.

Several points have to be taken into consideration in designing a systematic and thorough search for P.G.M. in a layered mafic to ultramafic sill:

a) P.G.M. are primarily discrete minerals associated with sulphides, chromite and magnetite.
b) P.G.M. may occur in both the mafic and ultramafic portions of a sill.
c) P.G.M. are concentrated in discrete mineralized layers of variable thickness (centimetres to metres) and extensive lateral continuity up to several km; the mineralized zone in the "Banded Zone" of the Stillwater Complex in Montana appears to be continuous over 39 km).

Thus it was recognized that a sampling program would be conclusive only if a complete, uninterrupted cross-section of the B.R.S. was recovered and assayed. Since the B.R.S. dips steeply, its thickness is exposed and a continuous sample cut from the rock's surface will provide a complete cross-section of the intrusion. A rock-cutting program in the Chrome area of the B.R.S. (Fig. GS-9-3) has provided a channel sample of 324 m length by 2-5 cm width and 6 cm depth. This section starts at the exposed base of the B.R.S. in ultramafic rocks and continues across the chromitite layers into the gabbroic portion. It represents slightly more than half of the thickness of the B.R.S. The sampling will be completed in 1983.

Initial laboratory work will consist of preparing samples at 10 m intervals assayed for sulphur. Those samples containing anomalous sulphur will then be analyzed over successively smaller intervals until the source of the sulphides has been identified. This sulphide-rich zone will then be assayed for P.G.M.

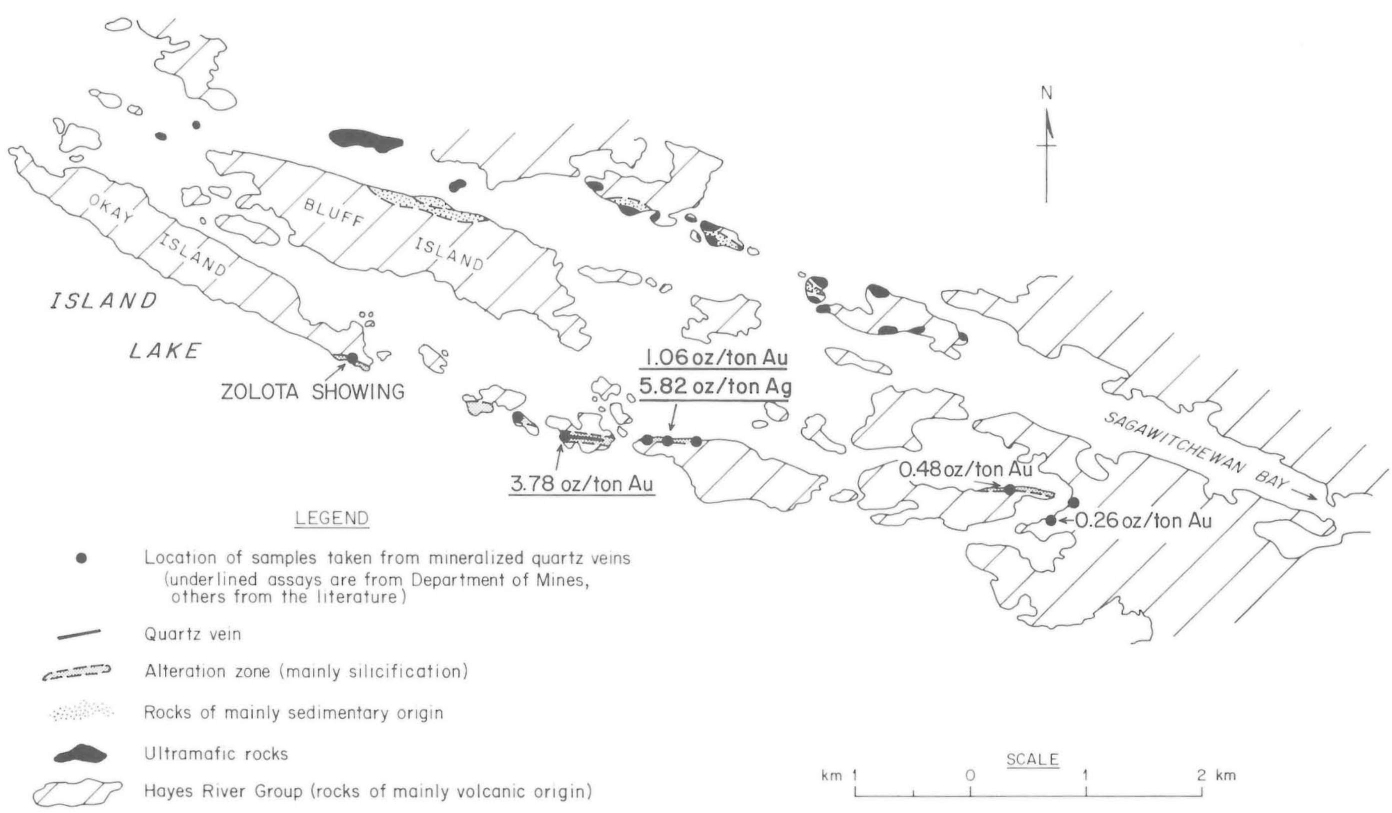

Figure GS-9-2: Gold mineralization south of Sandy Bar Narrows (Island Lake).

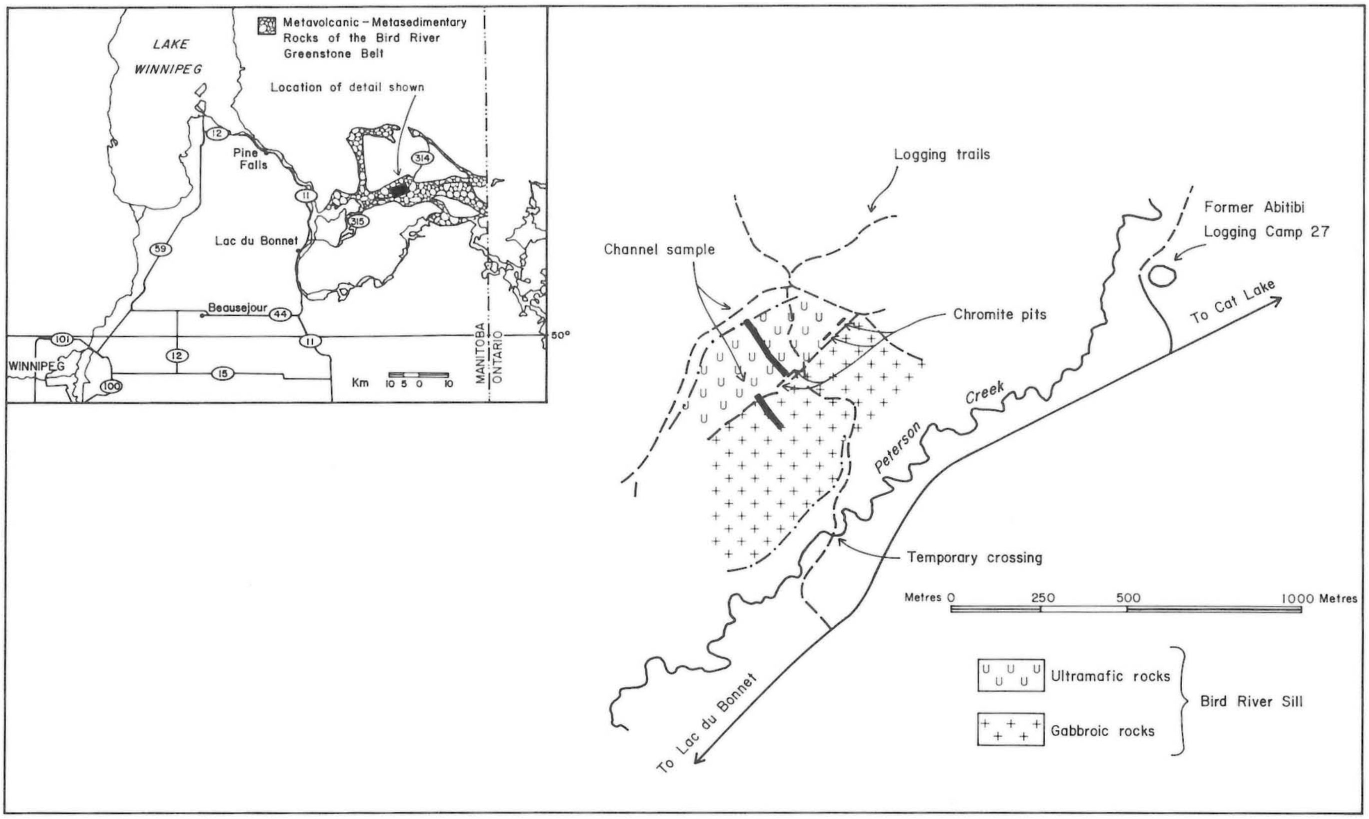

Figure GS-9-3: Location of channel sample, Platinum Group Minerals (P.G.M.) project, Bird River Sill.

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GS-10 MINERAL DEPOSIT STUDIES — SOUTHEASTERN MANITOBA

by M.A.F. Fedikow

Mineral deposit studies were initiated in the Gem Lake area (Fig. GS-10-1). to determine the potential for mineral deposits of the massive sulphide type in the felsic fragmental and associated rocks initially mapped by Weber (1971) as part of Project Pioneer. The ten-day reconnaissance program was undertaken to provide a framework for future studies.

GEOLOGY

The Gem Lake area is characterized by volcanic and sedimentary rocks of the Rice Lake Group that have been subdivided into the underlying Bidou Lake Subgroup, consisting of basalt, dacite and interlayered sedimentary rocks, and the overlying Gem Lake Subgroup, consisting of a differentiated basalt-rhyolite cycle and derived sedimentary rocks. Weber (1971) identified a felsic volcanic vent and a related high level sub-volcanic intrusion in the area. The rocks of the Rice Lake Group have been affected by three main periods of folding and fracturing and have undergone recrystallization during several periods of metamorphism. Details of the rock types in the Rice Lake Group including petrochemical studies are presented by Weber (1971).

RESULTS

The geological units mapped by Weber (1971) were reconnoitered along the shoreline of Gem Lake and by traverse. Geological details were difficult to discern due to the abundance of lichen and moss cover on the outcrop and thus a significant effort was expended in stripping and cleaning outcrop. During the course of the field work a 500 m x 200 m zone of pyrite $\pm$ chalcopyrite + sericite alteration was identified. This zone occurs in the southeast portion of Gem Lake in close association with flow rhyolite mapped as Unit 11 of the Gem Lake Subgroup (Map 71/1-5; Weber, 1971). The alteration zone is well exposed on the tip of a peninsula and a small island (Fig. GS-10-2) but could not be traced further due to a lack of exposure. The rhyolite in this location is extremely siliceous and in many places appears to be chert. The rocks are bleached and intensely iron stained with a patchy distribution of pyrite and sericite. The pyrite occurs as disseminated 1-3 mm grains and sporadically in discontinuous 5 mm laminae. Chalcopyrite grains are rare but usually occur in association with dark green to black chloritic(?) minerals. The sulphide content of the alteration zone averages 5% but can be as high as 15%. Samples have been collected for assay purposes, however, results are not yet available.

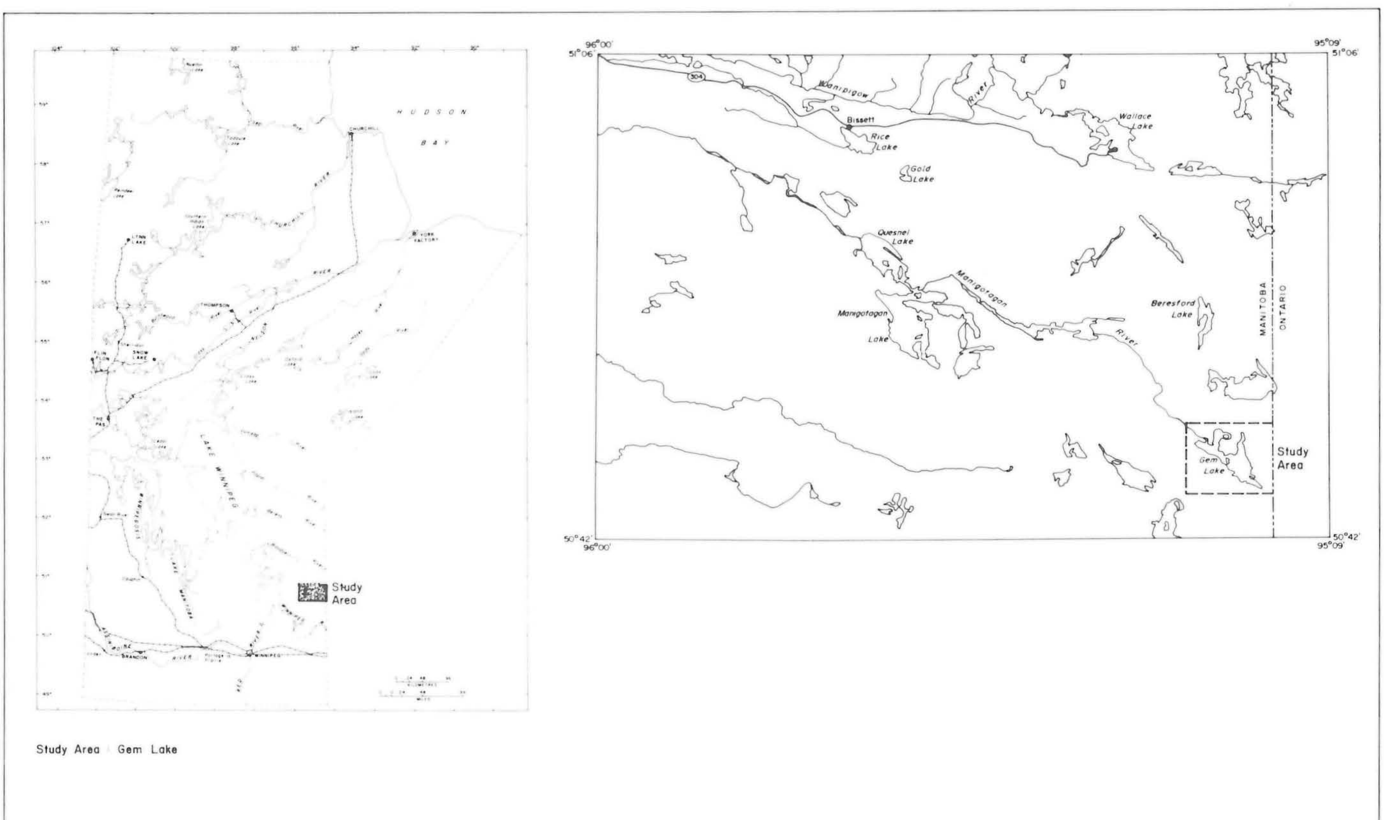

Figure GS-10-1: Location map of the Gem Lake study area.

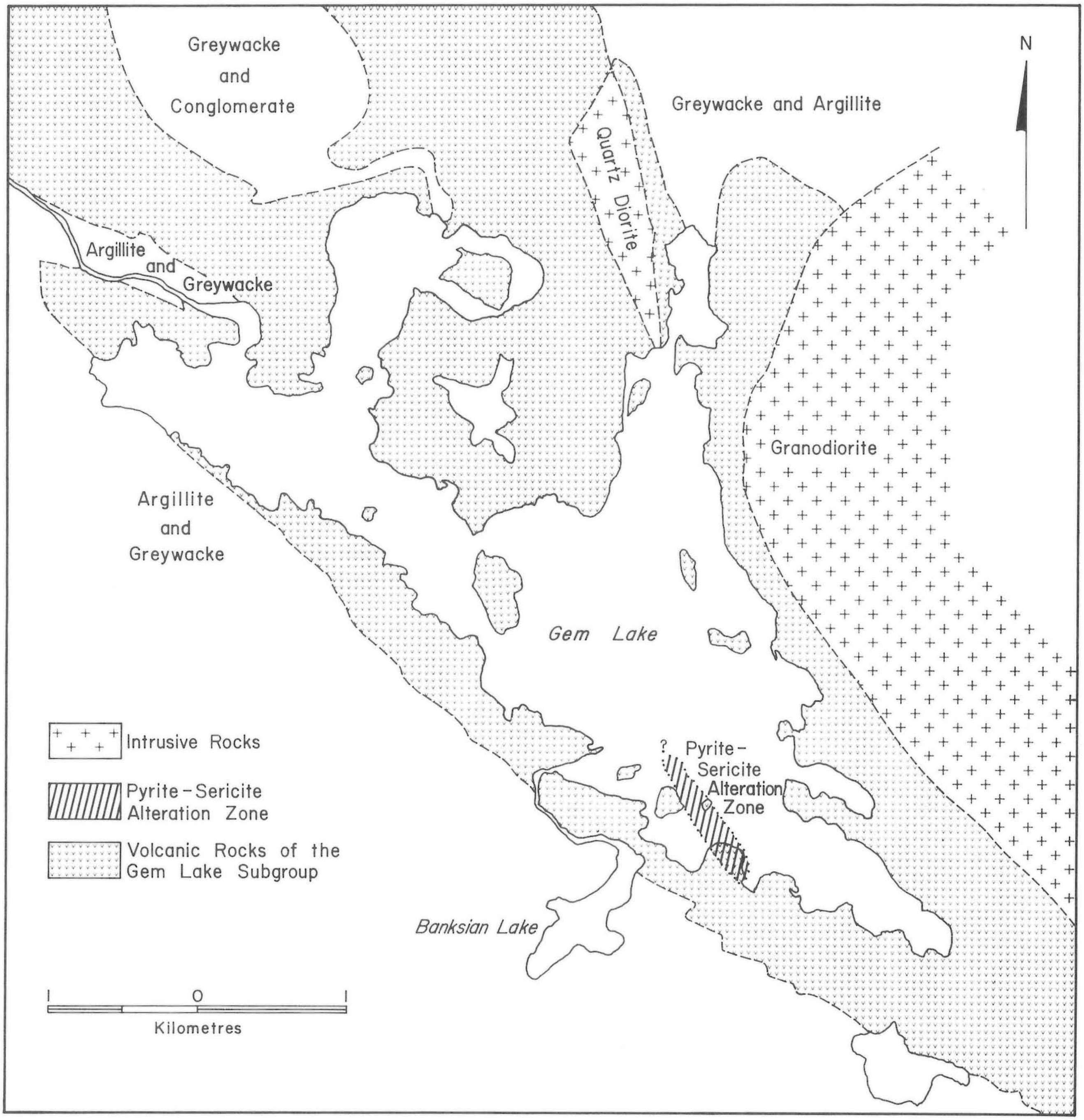

Figure GS-10-2: General geology of the Gem Lake area showing the location of the pyrite-sericite alteration zone (modified from Weber, 1971).

FUTURE WORK

The relationship of the alteration zone to the surrounding fragmental rhyolitic rocks and its significance in the context of a massive sulphide-exhalative process is uncertain. Detailed geological mapping and stratigraphic studies in the Gem Lake area, particularly in the vicinity of the alteration zone, are anticipated.

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GS-11 CHROMITE RESOURCES OF THE BIRD RIVER AREA

by David M. Watson

INTRODUCTION

Chromite was first discovered in the Bird River area on the Wards claims in 1929. Since that time the area has been extensively explored for chromite along with copper, nickel and other metals. A history of the area along with a description of the geology are given in the recent report by Bannatyne and Trueman (1982).

This study, a joint project of the Manitoba Department of Energy and Mines and the Geological Survey of Canada, is the first part of an attempt to accurately determine the extent of the chromite deposits, and their reserves. Ultimately the study will include reserves, iron-chrome ratios and distributions, distribution of platinum and other elements, and the economic potential of the area.

The work conducted this year included collection of samples from the various properties (Fig. GS-11-1) for chemical analysis and petrographic study, and a test profile across the Chrome property with an EDA Instruments gradiometer to determine the feasibility of using this instrument to delineate the chromite seams.

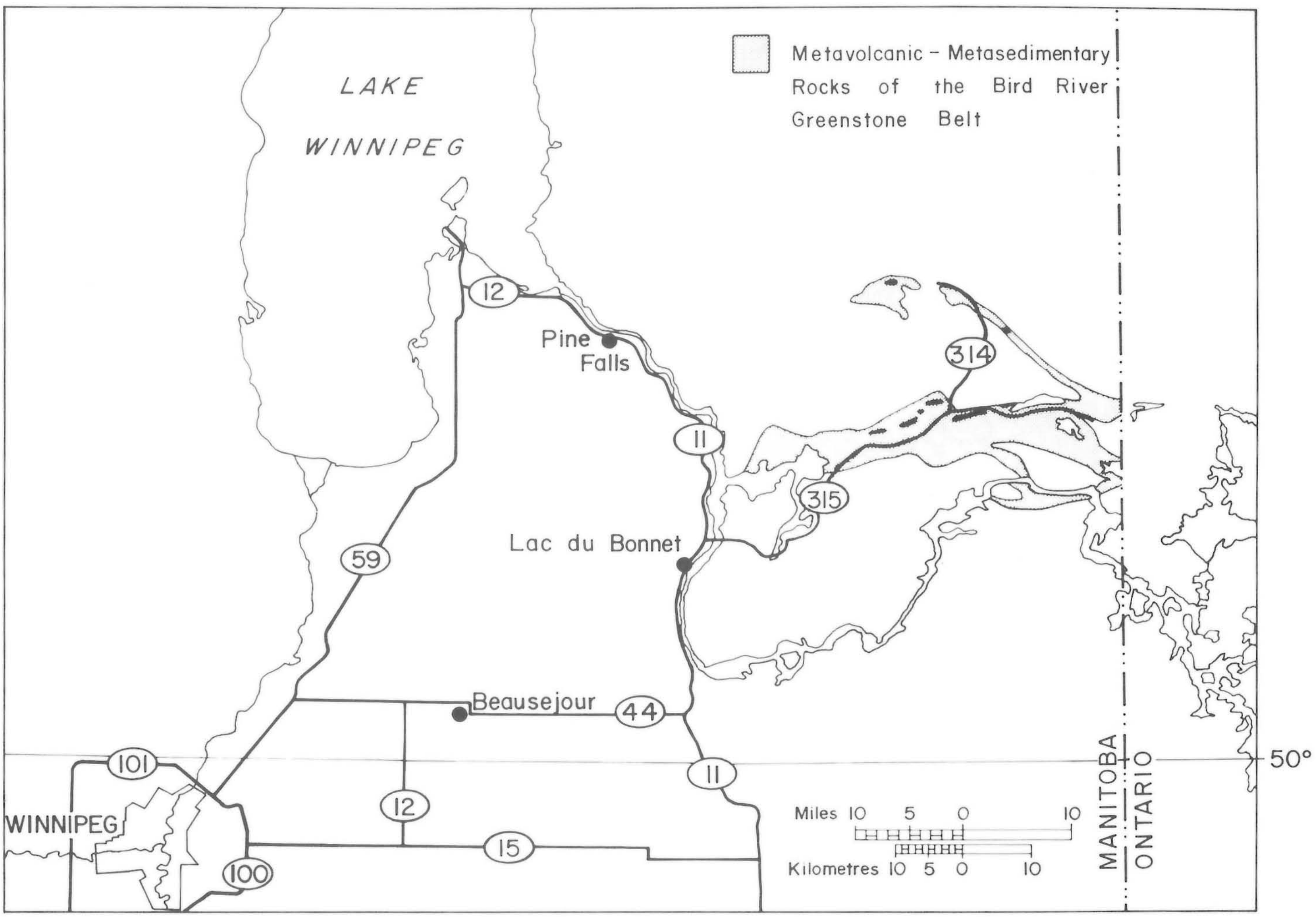

Figure GS-11-1: General geology and property locations, Bird River Sill.

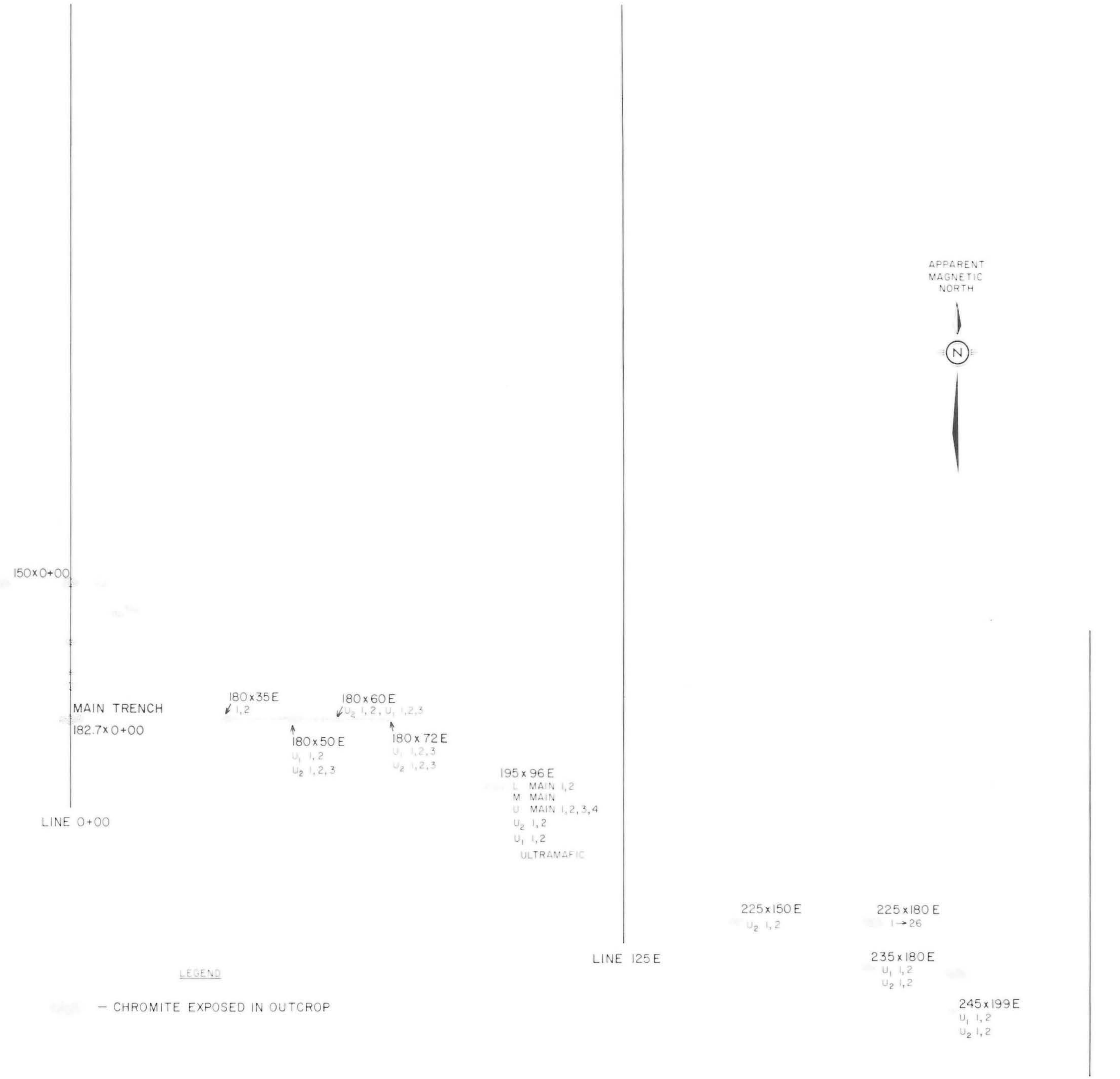

Figure GS-11-2: Sample locations - Chrome Property.

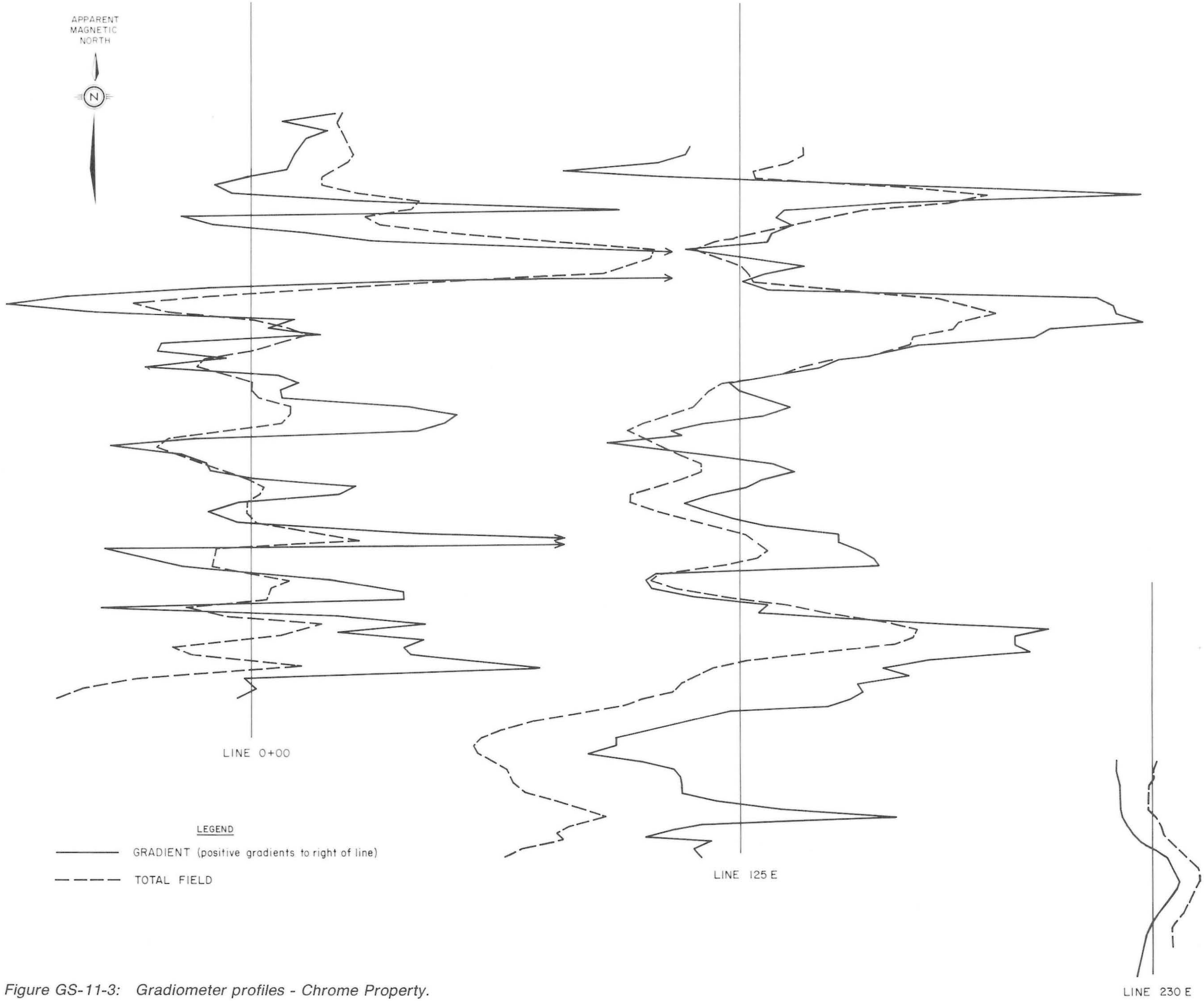

Figure GS-11-3: Gradiometer profiles - Chrome Property.

SAMPLE COLLECTION AND ANALYSIS

The Chrome property was selected as the main area of the study. This was primarily because of the excellent exposure of the various chromite horizons and also because of the easy access. In addition, this property has been the subject of much of the exploration work conducted by companies and individuals over the years.

A base line was run across the property roughly parallel to the line being sampled by Dr. Theyer of the Department of Energy and Mines (Theyer, 1982). This line served as a reference line for the initial sampling and as a base line for the lines going to the other trenches. Samples were taken along this line wherever there was an indication of chromite or a change in rock type. The locations of these samples are shown in Figure GS-11-2. The specimens collected were sawn in two and one half sent to Carleton University for preparation of polished sections. The other half has been retained by this department for possible future study.

GRADIOMETER SURVEY

Although on the Chrome property there is abundant outcrop, there are many other areas of the Bird River Sill where the rocks are covered by various types of overburden. An EDA Instruments gradiometer was used to run three profiles over the property. The first profile was run along the base line which was sampled as part of the sampling program. The second was run across the property about 250 m east of the base line. The last set of readings was taken a further 100 m east in an area of water saturated swamp. There was no outcrop in this area, however; the most easterly trench was approximately 50 m to the west. The sample spacing in each case was approximately 2 m.

In each case there were anomalies detected that, at least where they could be observed, correspond to the chromite veins. In the case of the third line, the one anomaly was on strike from the most easterly trench (Fig. GS-11-3).

It would seem from the results of these three lines that the gradiometer is a useful instrument in delineating the chromite seams. Whether or not it will work with greater thicknesses of overburden has still to be proven.

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1982: Chromite Reserves and Geology of the Bird River Sill, Manitoba; Manitoba Mineral Resources Division Open File Report OF82-1.

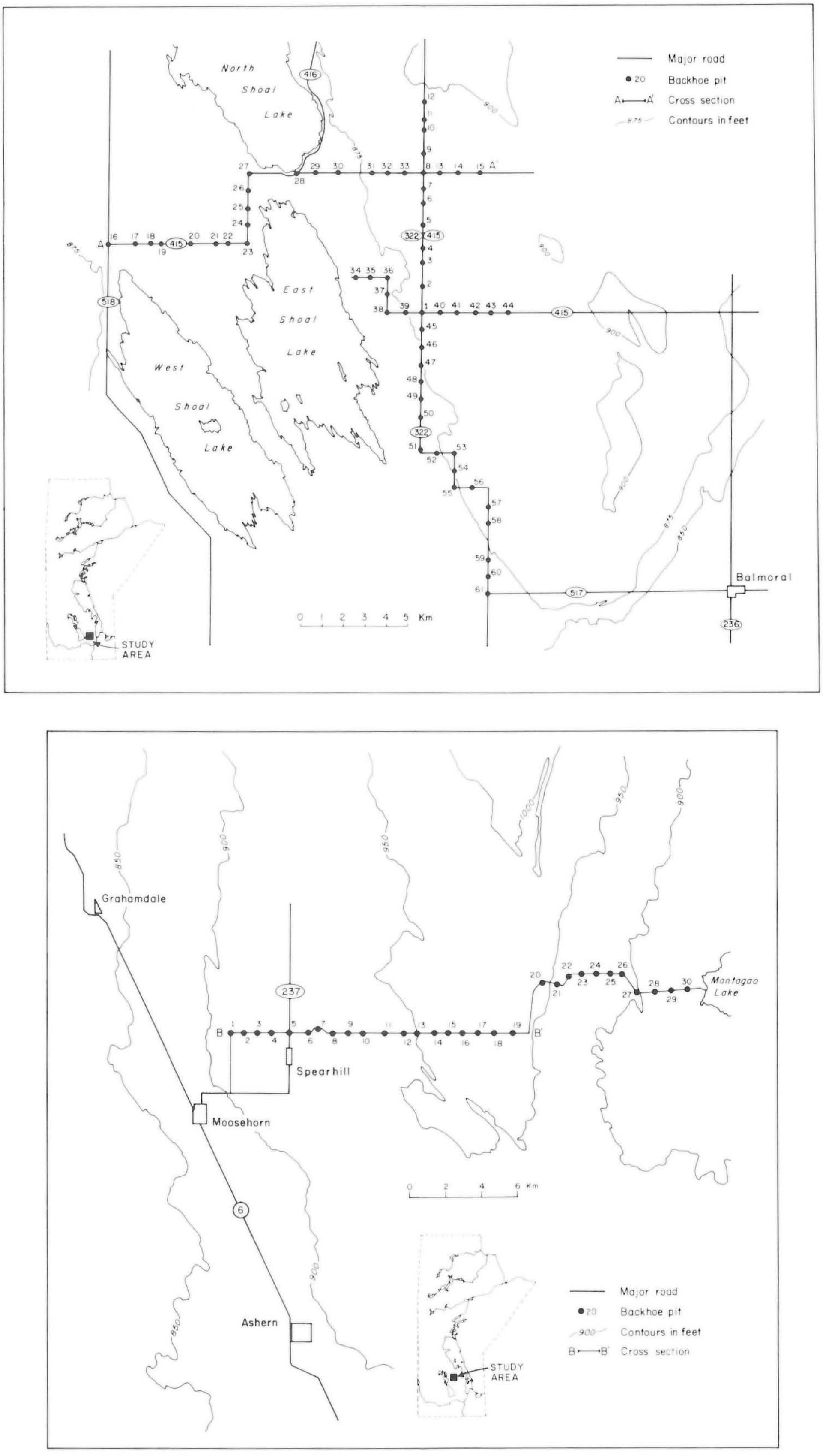

Figure GS-12-1: Location of the samples collected in (A) the Shoal Lake area and (B) the Moosehorn area.

GS-12 MINERAL DEPOSIT STUDIES IN PHANEROZOIC ROCKS OF SOUTHERN MANITOBA

by E. Nielsen

INTRODUCTION

The multi-discipline project initiated last year (Gale **et al.**, 1981) in search for the origin of the mineralized pebble discovered on Doan's farm near Balmoral was continued in 1982. Added incentive to the search for lead-zinc mineralization in the Paleozoic carbonate rocks was provided in August of this year when an angular pebble (3 x 3 x 7 cm) with slightly rounded edges was found by Mr. Ron Kostiuk in the Porcupine Mountains and brought into the Branch for identification. Isotopic analysis to determine the age of the pebble is being undertaken in co-operation with the University of Alberta.

This year's activities included: (1) an analysis of the Quaternary stratigraphy in the vicinity of the Shoal Lakes, and in the area to the south of Lake St. Martin, i.e., the up-ice direction to the Balmoral area, (Fig. GS-12-1), and (2) sampling of Paleozoic rocks in drill core. Geochemical analyses of the till samples collected to date will be presented at a later date.

STRATIGRAPHY OF THE SURFICIAL DEPOSITS

A total of 91 backhoe pits were put down. Sixty-one pits around the Shoal Lakes resulted in 92 samples and 30 pits in the Moosehorn area south of Lake St. Martin provided 47 samples (Fig. GS-12-2). The backhoe pits ranged in depth from approximately 1 m where bedrock or hard till was intersected near the surface, to a maximum depth of 4 m where soft till or clay was encountered.

Two stratigraphic units correlatable with the stratigraphic succession reported previously for the Balmoral area appear ubiquitously throughout the area. Fissile, compact basal till constitutes the lowermost unit and probably directly overlies the bedrock at most sites. The thickness of the basal till is still unknown as the hardness prevented it from being penetrated for more than 1-2 m with the backhoe.

The compact basal till is overlain by a thin (1-2 m) but variable thickness of relatively soft diamicton. In the spring and early

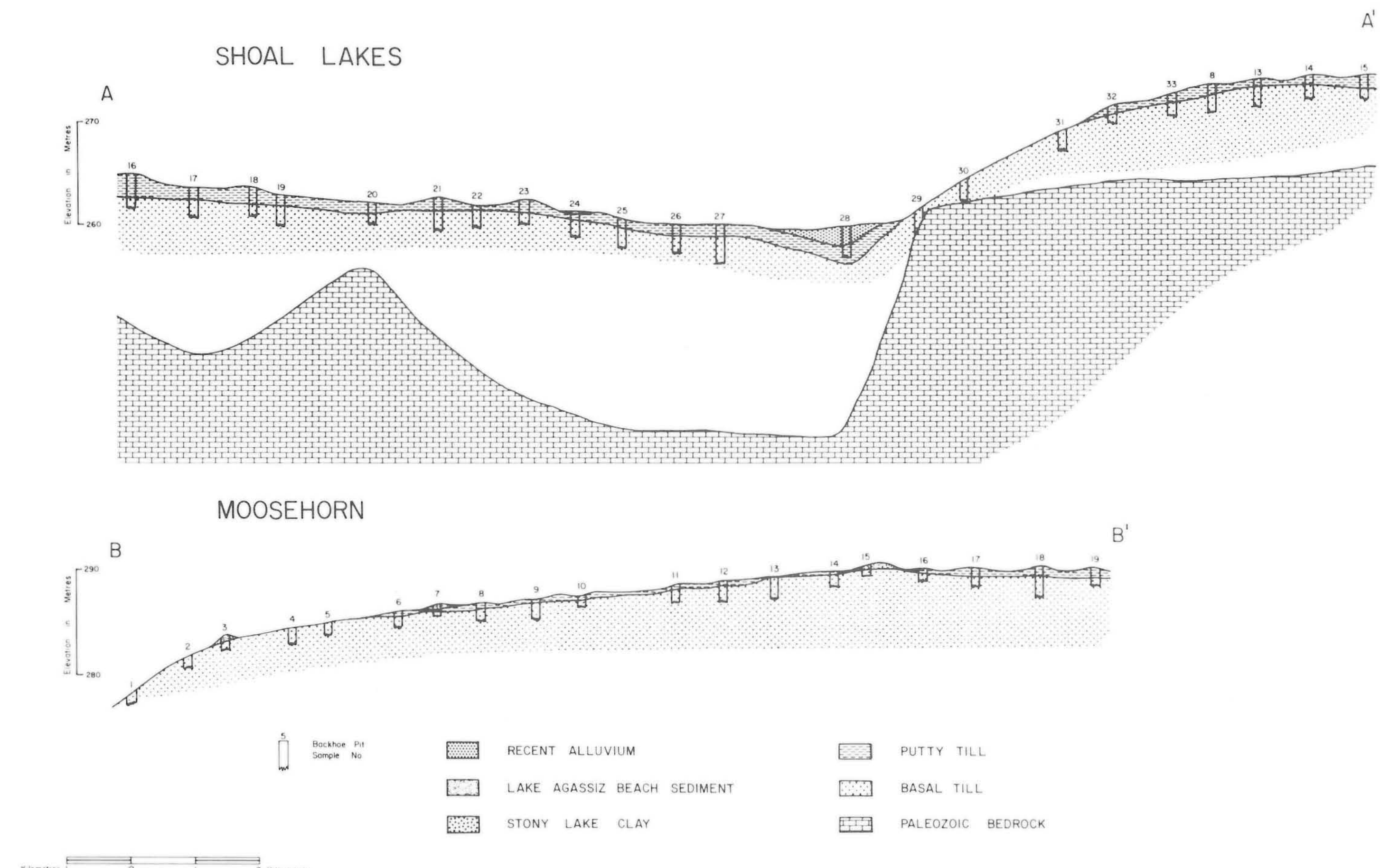

Figure GS-12-2: Stratigraphic cross-sections of the surficial deposits in the Shoal Lakes and Moosehorn areas. Depth to bedrock data from J.F. MacLaren Ltd., 1981.

summer this unit is characteristically uncompacted and soft, however, by the end of the summer, when it has dried out, it becomes hard and difficult to differentiate from the underlying basal till. Its putty-like nature in the spring has led to it being informally termed 'putty till'. It is easily differentiated from the basal till by the unconfined strength (Fig. GS-12-3). The 'putty till' is composed either entirely of massive soft pinkish grey (5YR 8/1) till or less commonly

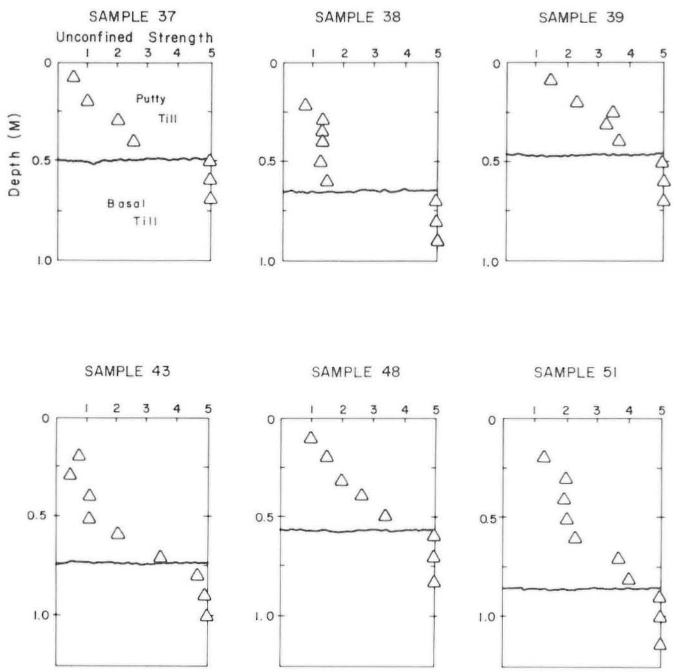

Figure GS-12-3: The relative unconfined strength in kg/cm² as measured with a pocket penetrometer in the "putty till" and the basal till in the Shoal Lakes area.

a massive olive grey (5Y 4/1) stony lake clay. Typically however, the 'putty till' is composed of variable mixtures of these two types of sediments giving it a mottled appearance. The upper surface of the 'putty till' is invariably criss-crossed by iceberg furrows (Fig. GS-12-4). The 'putty till' is believed to have resulted from the mixing by icebergs, of underlying basal till with an overlying proximal ice marginal stony lake clay thereby producing an uncompacted mottled diamicton with a gentle swell-and-swale morphology. Alternatively the 'putty till' may have formed by a glacial readvance into a proglacial lake. A till produced by this glaciation could then have been subsequently reworked by iceberg ploughing to produce the 'putty till'.

The basal till and the 'putty till' are sporadically overlain by a thin layer of undeformed massive, olive grey (5Y 4/1) stony lake clay. Nearshore sand and gravel deposited during the final regression of Lake Agassiz overlies the older deposits in only a few holes.

BEDROCK GEOCHEMISTRY

Drill core from the Mineral Resources Division's drilling of the Phanerozoic rocks in Manitoba were prepared for geochemical analyses. The Paleozoic rock sections were sliced to provide a continuous sample over a 1 m interval. The 800 samples will be analyzed for selected trace elements. The locations of the drill holes sampled are shown on Figure GS-12-5.

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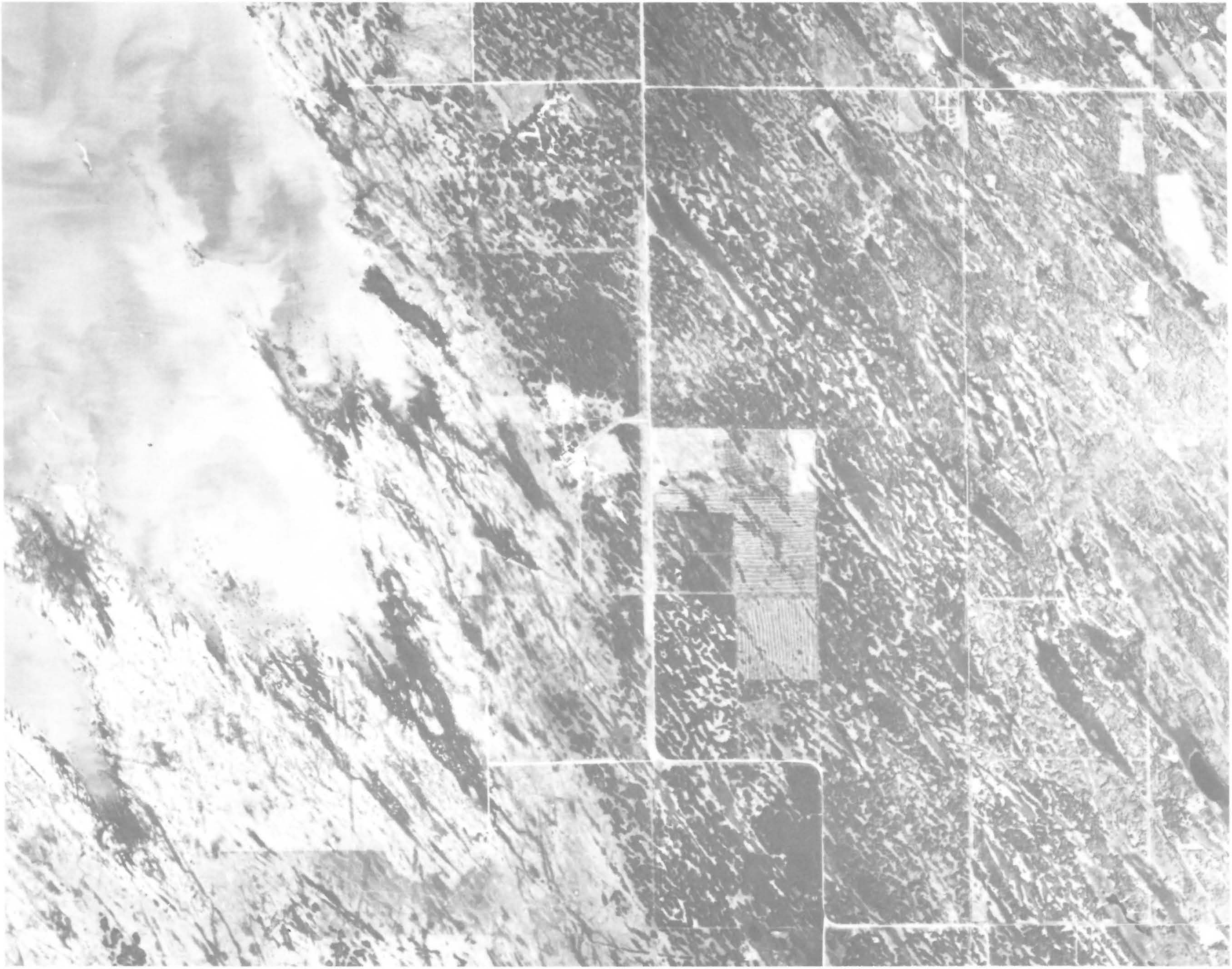

Figure GS-12-4: Iceberg furrows in the "putty till" in the area west of East Shoal Lake.

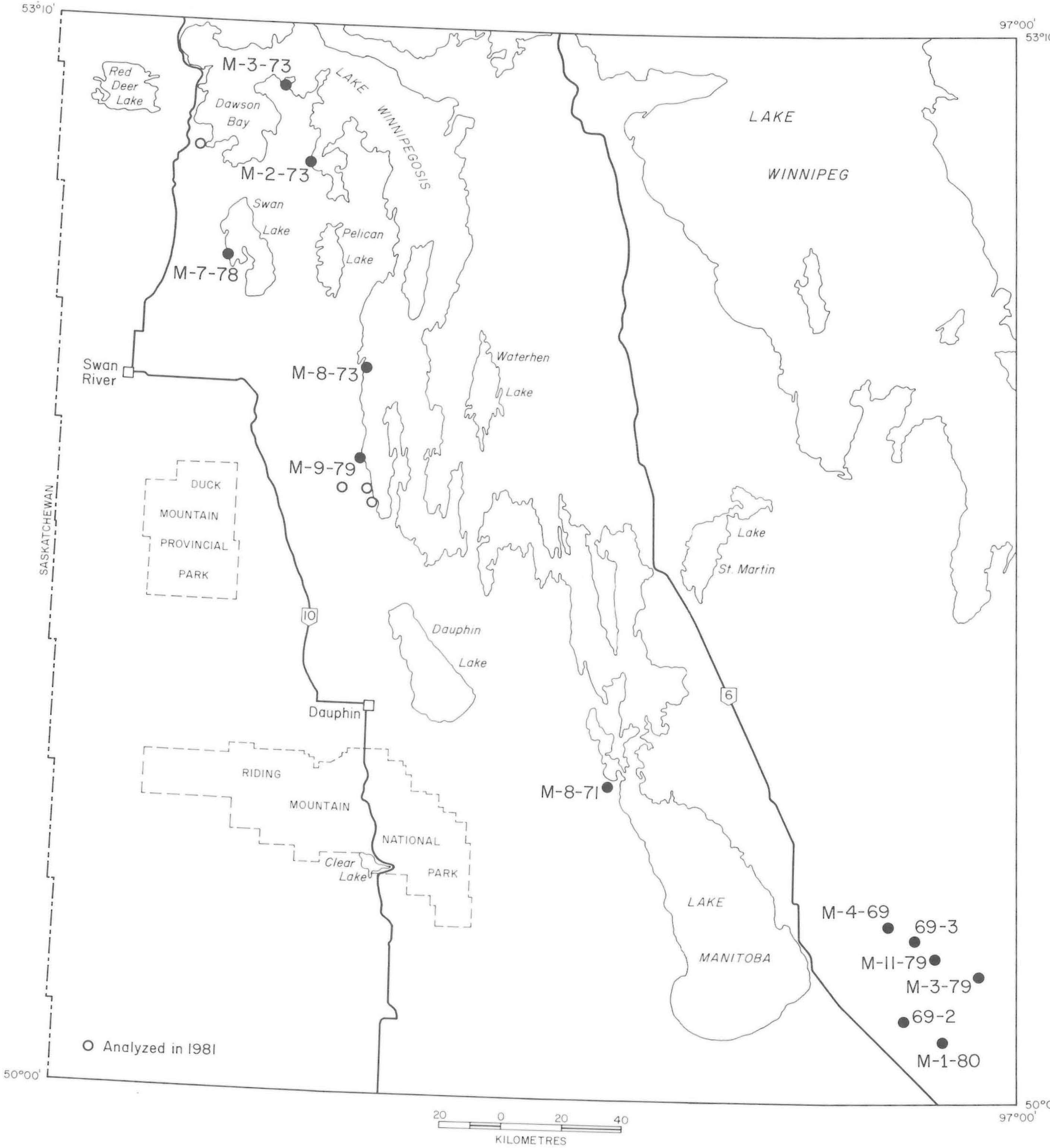

Figure GS-12-5: Location of drill hole cores sampled in 1982 (solid circle) with hole numbers. Core samples in 1981 shown with open circles.

GS-13 HIGH ROCK LAKE CRATER STRUCTURE

by H.R. McCabe

(in collaboration with B.B. Bannatyne and W.D. McRitchie)

Additional mapping, core hole drilling and ground magnetometer profiling were carried out in the High Rock Lake area to obtain further information on the nature and origin of the crater structure. Previous studies (Reports of Field Activities 1979, 1981) outlined a roughly circular feature of probable meteorite impact origin. The new data add much to our knowledge of the structure's shape and configuration, but provide no definitive evidence as to its origin. The structure, however, is shown to be considerably more complex than previously believed. Summary drill hole descriptions are included in Table GS-14-1, a structural cross-section utilizing the drill hole data is presented in Figure GS-13-2, and ground magnetometer profiles are shown in Figure GS-13-3. The regional map (Fig. GS-13-1) shows the distribution of the 1982 drill holes and magnetometer profiles.

Limited geological mapping focussed on the northward continuation of the uplifted granite rim, on the southwestern flank of the structure. The topographic continuation of this rim is shown on the newly released 1:20 000 photo-base topographic map 62P/5NE, available from the Manitoba Surveys and Mapping Branch. The main granite rim outcrop is not continuous to the north. Structurally disturbed, partly brecciated dolomites were found on this topographic ridge, with dips ranging from 45° to 90°. Outcrops are poor and some occurrences may be large loose blocks. Three additional structurally disturbed dolomite outcrop belts were located from 120 m to 215 m southwest of the southwestern granite.

Ground magnetometer profiles provided equivocal results which are difficult to relate to the structural configuration of the crater. Discussion of these profiles is included as an Appendix.

CORE HOLE RESULTS

Data for the 7 stratigraphic core holes drilled in the High Rock Lake area are shown in Table GS-14-1. Stratigraphic correlations based solely on lithology were attempted where possible, but in much of the section specific correlation is not possible. The degree of brecciation was noted, as was the degree of mixing of different lithologies (i.e., different stratigraphic units). In this regard the distinctive argillaceous beds of the Lower Stony Mountain provided a valuable marker. In the following account, each hole is discussed individually, since each hole seems to add a new dimension to the structural picture.

Hole M-2-82 was located close to the postulated limit of structural disturbance (and near the only available water supply). It was hoped that this hole would provide a "normal" reference section for the crater area. Surface samples obtained in 1981 indicated a fine mixed dolomite breccia (microbreccia), which was interpreted as a possible fallback breccia. The upper 4.3 m of core consist of variably brecciated and mixed dolomite comparable to that seen in outcrop. Below this is a 13 m section of reddish mottled argillaceous dolomite that is correlated with the Lower Stony Mountain Formation (Gunn/Penitentiary equivalent). This lithology is rather distinctive, and correlation is reasonably certain, but the beds show some degree of internal disruption, almost a "flowage" texture rather than a brecciation. No foreign fragments are included in the Lower Stony Mountain sequence, and it appears "intact", if somewhat disturbed.

Below the Stony Mountain beds, the section reverts to a slightly mixed brecciated section, ranging from fine mixed breccia with fragments generally less than 5 cm (microbreccia), to medium breccia with fragments up to 1 m. This in turn grades to a generally coarser breccia with fragments commonly larger than 1 m, interspersed with intervals of microbreccia. Lithologies consist of grey and brown, dense to moderately granular, finely crystalline to microcrystalline dolomite with some cherty and argillaceous intervals. This range of lithologies is generally correlatable with the upper part of the Ordovician Red River succession, except that limestones or calcareous rocks are not present. This sequence is interpreted as an in-situ breccia with relatively little vertical (stratigraphic) mixing.

Below 69.5 m the section consists of "normal" buff to reddish mottled finely crystalline dolomite with scattered fossil fragments, and no apparent disruption or brecciation. These beds are correlated with the lower part of the Red River Formation, but differ from the expected Red River lithology in that they are totally dolomitized. This applies not only to hole M-2-82 but to all holes drilled to date in the High Rock Lake area. All rocks are totally dolomitized with no relict calcareous material. Towards the base, the Red River strata become darker grey to reddish mottled and argillaceous, and grade into normal-appearing sandy shales of the Winnipeg Formation at 117 m. Drilling problems prevented penetration to Precambrian basement, but based on regional thickness estimates, Precambrian would have been intersected at 155 m, or an elevation of +90 m (Fig. GS-13-2).

These results show a considerably greater degree of structural disruption than had been anticipated at a point close to the postulated limit of structural disturbance. Also, the suggested "fallback" breccia mapped on surface possibly is not a fallback breccia. Repeated occurrences of this lithology throughout much of the upper 70 m of the section (beneath an apparently "intact" cover of Lower Stony Mountain beds), confirms that this type of breccia can be formed more or less in situ. Lower Stony Mountain beds are the expected outcrop unit on the basis of regional mapping, and the total sedimentary section is approximately of the correct thickness. The estimated elevation of Precambrian basement is normal, within the limits of accuracy of regional extrapolation. The apparent lack of disturbance of the Lower Stony Mountain beds, as compared to the underlying brecciated Red River strata, most likely results from the difference in lithology, with the softer Stony Mountain shaly beds possibly deforming almost plastically in comparison with the brittle deformation evident in the carbonate beds. The limitation of structural disturbance to the upper 70 m of the Paleozoic succession suggests that the postulated limit of structural disturbance (Fig. GS-13-1) may be reasonably accurate.

Hole M-8-82 shows a section similar to that of M-2-82 but with a considerably greater degree of disturbance and disruption. Extensive fine to coarse brecciation is evident to a depth of 91 m, and stratigraphic mixing is pronounced. The cap of Lower Stony Mountain beds has been fragmented and intervals of Lower Stony Mountain lithology (i.e., fragments) are interspersed with Red River type lithology to a depth of 62.6 m. The longest coherent lithologic interval (i.e., largest fragment?) is approximately 5 m. The basal 24 m of the Red River appears normal, and the top of the sandy shale of the Winnipeg Formation was intersected at 115.5 m, almost the same depth and elevation as in hole M-2-82. The estimated basement elevation thus appears normal.

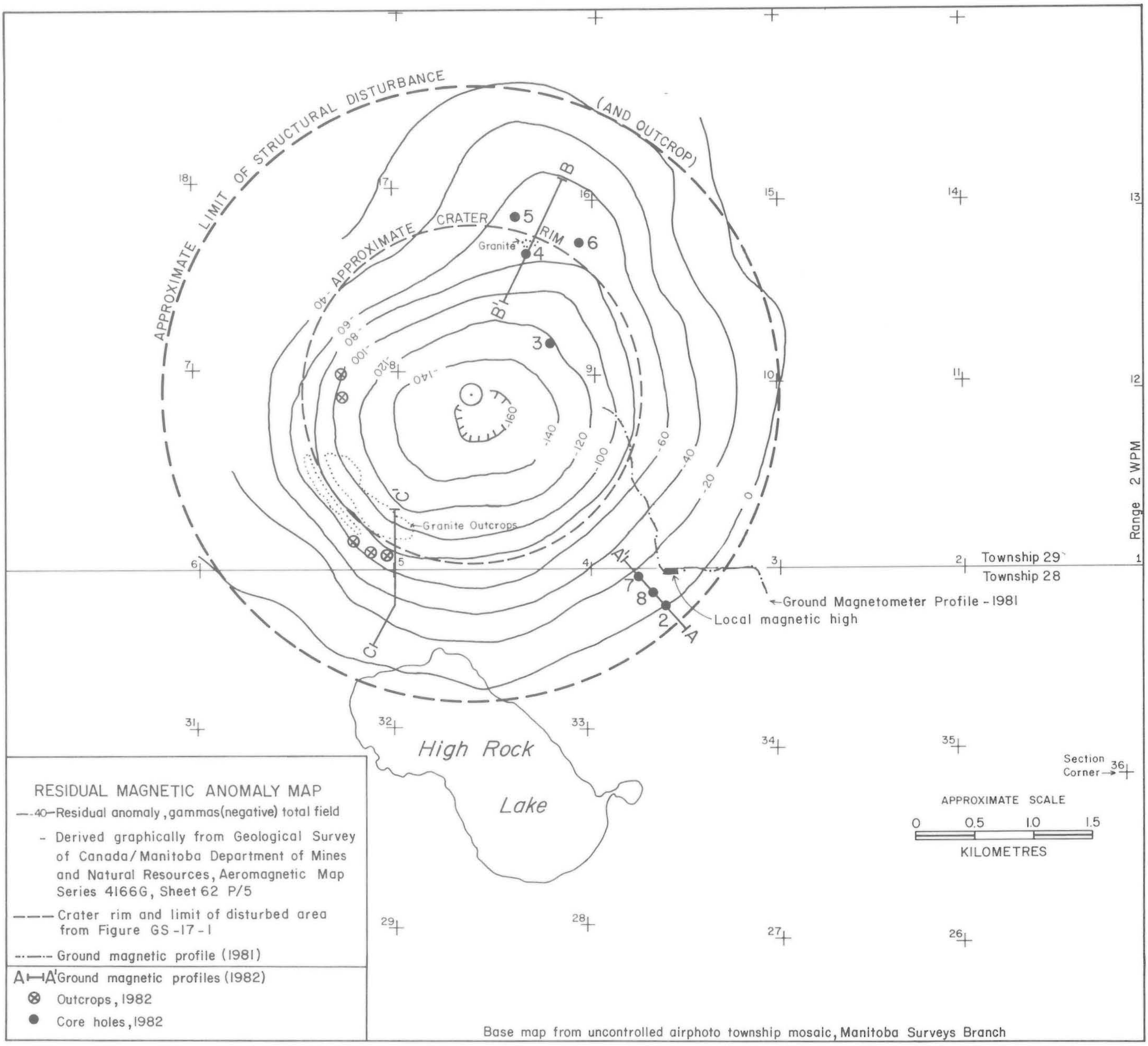

Figure GS-13-1: High Rock Lake Area - Location Map, 1982.

Hole M-7-82, the innermost hole on the southeastern flank of the crater, shows by far the greatest degree of disturbance of these three holes. The entire cored section, to a depth of 124.2 m, is a mixed fine to coarse breccia. Intervals of Lower Stony Mountain type lithology occur to a depth of 115 m (except for the top 22 m). The basal 0.4 m consists of massive relatively clean sandstone with a few included dolomite fragments at the top. This lithology is not correlatable with upper Winnipeg beds, which normally consist of sandy shales, as intersected in holes M-2-82 and M-8-82, but rather appears correlative with middle or lower Winnipeg beds. It is not clear if this sandstone is in place or represents a breccia fragment; as a result, accurate estimation of the elevation of Precambrian basement is not possible. Within limits, basement cannot be more than about 10 m above normal elevation.

Hole M-5-82 was located on one of the first outcrops north of the northern granite rim. Outcrop mapping had indicated flat-lying to moderately dipping strata tentatively correlated as Stony Mountain Formation; however, this correlation seemed, at the time, questionable because of the proximity (180 m) to Precambrian outcrop. Normally, Lower Stony Mountain beds are underlain by about 150 m of Red River and Winnipeg strata and, accordingly, the entire stratigraphic section (if present) would have had to be almost vertical to fit within the available space. Such structural configuration seemed unlikely. The drill core, however, indicates a much condensed section. The upper 20.5 m consists of reddish mottled argillaceous dolomite typical of the Lower Stony Mountain, but rather highly deformed internally, with apparent dips ranging up to 45°. Below this, a thin 4.6 m section of fine car-

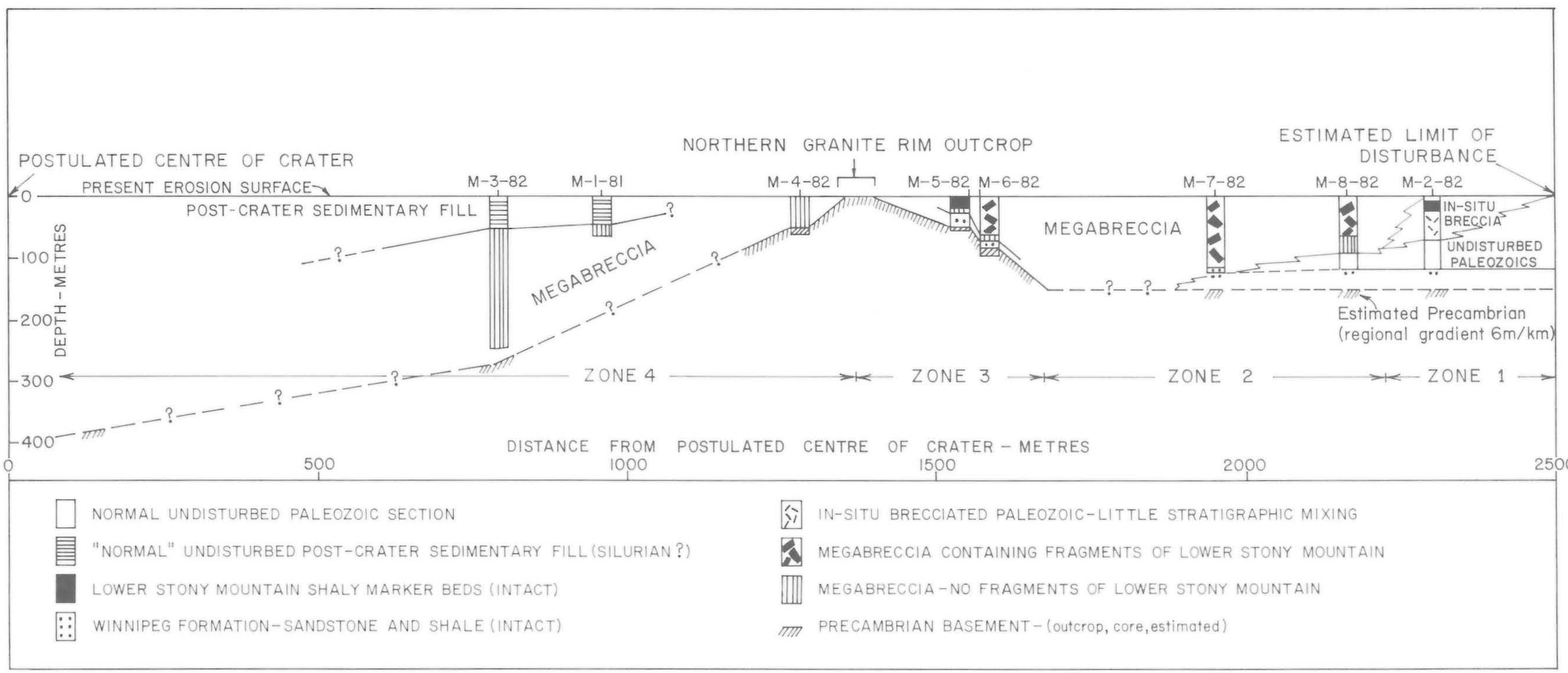

Figure GS-13-2: High Rock Lake - Structure Cross-Section, 1982.

bonate breccia composed of Red River type lithologies passes sharply downward to a 23 m sandstone and argillaceous sandstone correlatable with the lower part of the Winnipeg Formation. The sandstone is in turn underlain, at a depth of only 48.1 m, by a normal-appearing High Rock Lake type granite, complete with 0.3 m weathered zone. Precambrian basement is thus about 120 m structurally high. The calculated outward dip on the Precambrian surface, as determined from hole M-5-82, is only 17° compared to the 30° dip estimated on the basis of last year's shallow core hole program.

The complete absence of 120 m of Red River and Upper Winnipeg lithologies in this drill hole explains the proximity of Lower Stony Mountain outcrops to Precambrian outcrops, but is perplexing, especially since the relatively soft beds of the Lower Stony Mountain and Lower Winnipeg are still preserved. The occurrence could be purely accidental (i.e. merely a large breccia block) or, as suggested previously for hole M-2-82, the less brittle (more plastic) beds may have been more resistant to impact brecciation than the carbonate beds, and possibly, in view of the proximity to the crater rim, the brecciated (now incompetent) carbonate beds slumped into the crater, and comprise the lower part of the crater fill (see following discussion).

Hole M-6-82 was located close to the postulated crater rim, but approximately 460 m east of the northern granite rim outcrop. This location was chosen in part to determine if there might be a northeast-trending structural break cutting across the crater in the area of the main swamp. The results, however, indicate a continuation of the typical brecciation into this area. Inasmuch as hole M-6-82 is located about the same distance out from the postulated crater rim as hole M-5-82, a roughly comparable degree of disturbance was expected. The upper 72.8 m of hole M-6-82 consist of a coarse megabreccia, with Lower Stony Mountain intervals comprising the dominant lithology to a depth of 62 m. The basal 10 m of the breccia zone consists of dolomite fragments of Red River type lithology with no admixed Lower Stony Mountain. This is underlain by a 15.3 m section of massive medium grained sandstone with a few included dolomite fragments near the top. Massive normal-appearing High Rock Lake type granite was intersected at 88.1 m. A 0.15 m weathered zone is present at the top of the granite, and a 0.5 cm calcite veinlet was noted. Although the Paleozoic succession shows a somewhat greater degree of stratigraphic mixing than in hole M-5-82, the amount of missing section is less, and as a result, Precambrian basement is almost 40 m lower than in hole M-5-82, but still approximately 80 m high relative to expected regional elevation.

Two holes were drilled inside the crater rim, to check for shock-metamorphism in Precambrian basement samples, and to determine the continuity of the crater fill, particularly the apparently normal (but atypical) undisturbed sediments comprising the upper part of the crater fill, and interpreted as representing post-crater deposits.

Hole M-3-82 was located approximately 305 m northwest of hole M-1-81, and 550 m inside the estimated crater rim. This was thought to be far enough away from hole M-1-81 to test for stratigraphic continuity, and it was hoped that use of a larger drill rig would permit the hole to be taken to Precambrian basement. Preliminary estimates of depth to basement were made, based on an apparent inward dip of 30° on the Precambrian surface outlined by the shallow 1981 drilling at the northern granite rim. On the basis of a simplistic spherical excavation model, the expected depth to basement was 240 m. Drilling problems forced termination of drilling at a depth of 246.2 m, with no indication of approach to basement. Precambrian is thus more than 75 m below regional estimated elevation in the central excavated portion of the crater.

The upper 55 m of hole M-3-82 consist of, in ascending order: grey to reddish grey sandy argillaceous dolomite with dolomitic shale (32.4 m); pale yellowish brown fine grained dolomite, variable in texture, with some argillaceous fossiliferous interbeds and considerable pyrite (8.4 m); and buff to yellowish brown highly porous, highly fossiliferous dolomite (14.4 m). Bedding is not well shown in any of these units, but where seen dips range from flat-flying to a maximum of 15°. No evidence was seen of any appreciable brecciation. This appears to be a normal sedimentary sequence and is closely similar to that intersected in hole M-1-81, except for a slight thickening related primarily to the upper fossiliferous bed. Fossil age determinations have not been made as yet pending availability of additional outcrop and core samples, and the possible middle Silurian age proposed in 1981 is still the best estimate.

Underlying the normal but atypical sedimentary sequence is an 11.5 m section of microbreccia comparable to that intersected in hole M-1-81. In 1981 this was interpreted as a possible fallback breccia because of the pronounced mixing of lithologic types and lack of any sedimentary reworking. As noted earlier, however, similar beds have now been found within the Paleozoic section of the crater rim, where they could not possibly represent fallback breccia, but must have been formed in situ. Because of their central crater location, and position at the top of the crater breccia, the microbreccia beds in hole M-3-82 could represent a fallback breccia, but this interpretation is now open to question. The relatively thick uniform microbreccia section, in contrast with the thinner and more erratic nature of most other occurrences of microbreccia (both inside and outside the rim), and the apparent stratigraphic continuity of this unit between holes M-1-81 and M-3-82, still favour a fallback origin.

The sequence underlying the microbreccia, from 66.25 m down to total depth of 246.2 m consists of a mixed megabreccia/microbreccia sequence. Fine breccias are relatively rare, and fragment (interval) size ranges up to about 20 m. Almost all fragments are dolomitic, variable in texture and lithology, and generally correlatable with Red River type lithologies. It is worth noting that Lower Stony Mountain lithology is almost totally lacking in this sequence. This is not surprising in view of the relatively normal total thicknesses of Lower Stony Mountain intersected in drill holes outside the crater rim. By the same token, the "missing" Red River lithologies of the rim holes (M-5-82 and M-6-82) are seen to comprise most of the central crater fill (at least for that portion of the crater where data are available).

In addition to fragments of Red River lithology, sandstone and shale fragments of the Winnipeg Formation are of limited occurrence (66.25 - 67.8; 68 - 68.9; 78 - 81.5; 85.2 - 85.35; 211.6 - 212.2; 218.9 - 220.6). Somewhat surprisingly these occurrences are more common towards the top of the breccia pile. A single occurrence of granite was noted at 67.8-68.1; this fragment appears highly weathered (or altered?) and contains a veinlet of rounded quartz veins. This lithology closely resembles the disturbed granite of the northern outcrop rim.

Because basement was not intersected in hole M-3-82, a second hole, M-4-82, was located approximately 90 m inside the northern granite rim outcrop, where it was reasonably certain that the drill would be able to penetrate to the Precambrian. On the basis of a 30° dip on the Precambrian surface, estimated from the 1981 drilling, basement was expected at 53 m. It was intersected at 51 m, indicating that the 30° dip is continuous for at least a limited distance into the crater. Elevation of the Precambrian is 115 m above regional.

The crater fill consists of what appears to be a megabreccia, with minor intervals of microbreccia. The intensity of brecciation, however, is rather less than expected, with apparently intact intervals (fragments) up to 18 m. The sequence of lithologies also appears to be more or less normal (if abbreviated) with Fort Garry type lithology at the top underlain by mottled Lower Red River dolomite, with minor dolomitic sandstone and shale at the base. The Precambrian basement, however, shows no evidence of a weathered zone; veinlets of sandy dolomite are present towards the top, and "vuggy" veinlets or intervals of highly brecciated (almost vesiculated?) granite are common. This lithology is comparable to that seen in the northern rim outcrop, and seems to reflect the nature of the excavated basement surface.

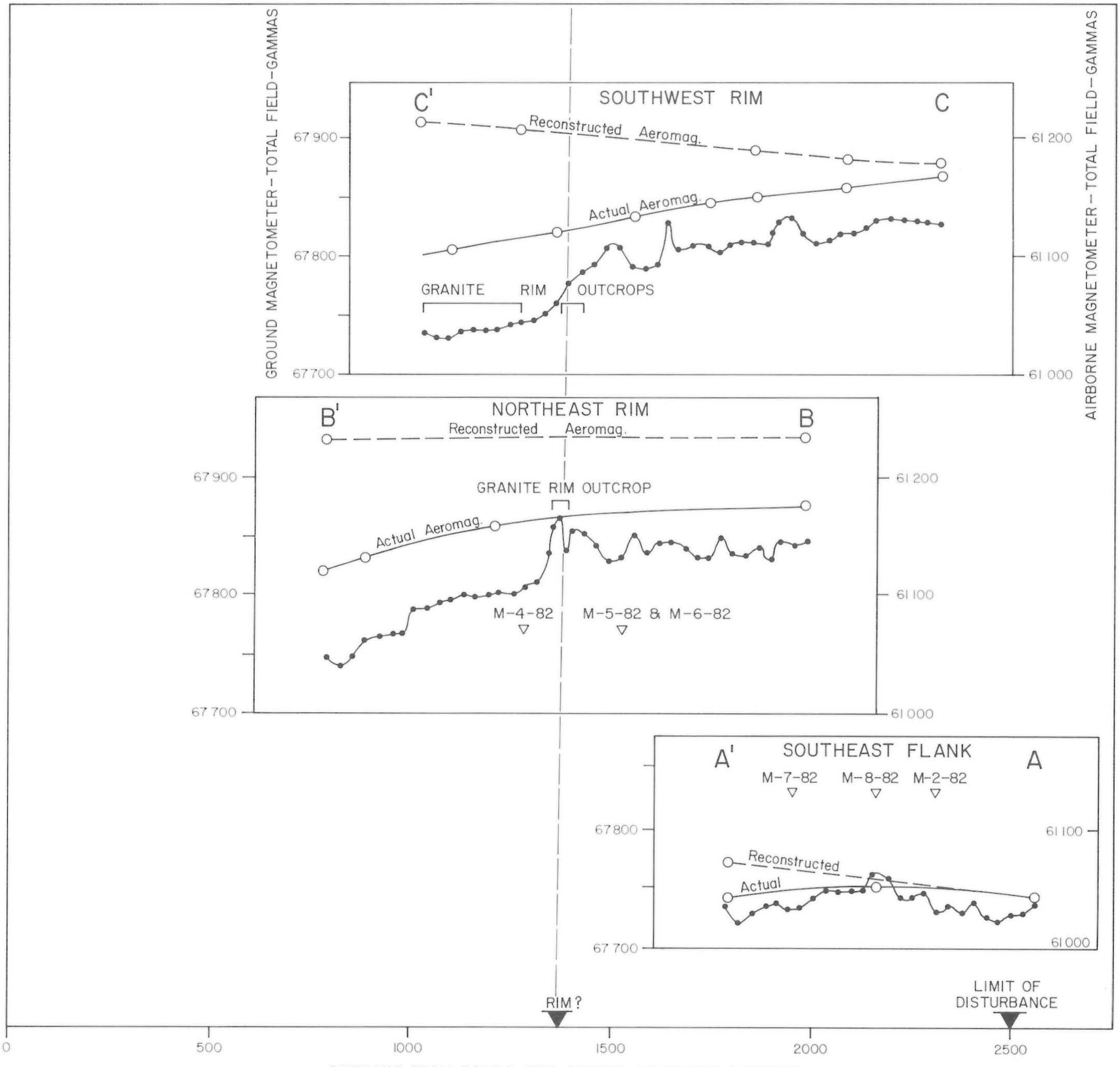

Figure GS-13-3: High Rock Lake Area - Ground Magnetometer Profiles, 1982.

INTERPRETATION

In summary, all of the newly acquired data, with the possible exception of the magnetic data, can be fitted to a modified crater impact model. A true-scale structural cross-section utilizing the drill results is shown in Figure GS-13-2. The relative positions of the holes are based on their estimated position relative to the centre of the crater, so that the cross-section represents a true-scale crater profile. On the basis of this profile and the foregoing core hole discussions, a **tentative** series of "tectonized" zones can be delineated. (The indicated distances are measured from the postulated centre of the crater structure).

Zone 1 — Outer rim — in-situ breccia zone (approx. from 2200 to 2500m): This zone is represented by hole M-2-82, where the upper 70 m (45%) of the Paleozoic succession shows varying degrees of brecciation, but no evidence of major stratigraphic mixing.

Zone 2 — Middle rim — sedimentary megabreccia zone (approx. 1680-2200 m): This zone is represented by holes M-7-82 and M-8-82, which show an increasing degree of Paleozoic megabrecciation and vertical stratigraphic mixing towards the postulated crater rim, to the point where the entire Paleozoic sequence is a megabreccia, but with no apparent structural uplift of basement rocks.

Zone 3 — Inner rim — basement uplift and megabreccia/slump zone (1370 m (rim) — 1680 m): This zone is represented by holes M-5-82 and M-6-82 (and the granite outcrops on the northeastern and southwestern rims). Basement uplift amounts to about 75 m on the northern rim, and more than 95 m on the southwestern rim (possibly 190 m). The most surprising, and probably most significant feature of this zone is the apparent "stability" of the Lower Winnipeg and Lower Stony Mountain formations under conditions of maximum structural disturbance.

Zone 4 — Central crater — zone of basement excavation, slump breccia and post-crater sedimentary infill (approx. 0 to 1370 m): This zone is represented by holes M-3-82 and M-4-82. Minimum basement relief between crater rim and central excavation, as evidenced by hole M-3-82, exceeds 260 m, and maximum relief probably exceeded 500 m.

It must be stressed that the above zones, and in particular the position and extent of the zones, are based on a small amount of data and are highly conjectural. Undoubtedly, marked structural variations occur within the crater, despite the apparently uniform circular configuration outlined to date.

One almost completely unknown factor that must be considered in interpreting the mode of crater deformation is the probable shallow marine condition that existed at the time of crater formation — if the postulated Silurian age is correct. The damping effect of a seawater blanket would have affected the mode of deformation, and could possibly aid in explaining the apparent "stability" of Lower Stony Mountain beds in the crater rim. Also, the possible "fluidizing" effect of the water could have promoted slumping of the crater walls. (The presence of Lower Stony Mountain beds throughout the crater rim suggests that little post-crater erosion has taken place, and that the original crater rim was greatly suppressed, if not lacking in some areas).

Much new data will be required before a detailed crater model can be proposed with any degree of confidence.

APPENDIX — GROUND MAGNETOMETER PROFILES:

The ground magnetometer profile presented in the 1981 Report of Field Activities indicated the presence of a pronounced magnetic high on the southeastern flank of the structure. It was suggested that this could possibly reflect a structurally uplifted basement block. This year, several additional radial profiles were run, to determine magnetic response in areas of known basement uplift. One profile was run in the vicinity of the previously reported high, a second across the northern granite rim outcrop, and a third across the southern granite rim. These profiles (Fig. GS-13-3) show markedly different responses across the uplifted granites. For comparison purposes all profiles are shown in their estimated positions relative to the crater center and rim.

Figure GS-13-3 (A-A') shows a northwest/southeast profile across the outer portion of the postulated crater rim. The three drill holes located on this profile have been discussed in detail in a previous section. The southeastern portion of the profile shows a gradual, slightly irregular magnetic rise to the northwest with a small peak of about 20 gammas at about 2175 m. This peak appears to represent the continuation of the more prominent high shown by the 1981 profile (and suggested as a possible basement high). From this point the magnetic values drop off fairly rapidly towards the center of the crater. The location of this profile was chosen because of the ease of access for drill equipment. A comparison between magnetic profile and drill hole data (Fig. GS-13-3 (B-B'), shows a relatively uniform basement elevation, suggesting little or no correlation between magnetic values and depth to basement.

Figure GS-13-3 (B-B') shows a radial profile across the northern granite rim outcrop. Since the profile parallels the reconstructed regional aeromagnetic trend, the profile should directly reflect the crater anomaly, with no "distortion" due to the regional magnetic gradient. This seems to be borne out by the profile, which shows a more or less flat response north of the granite. A small peak of about 25 gammas occurs coincident with the granite rim, and a sharp drop off is evident immediately inside the rim. Core hole M-4-82 was located on the magnetic profile 91 m south of the granite rim, and a second hole, M-5-82, 170 m north of the granite and 170 m west of the profile (Fig. GS-13-1). In general, the structure on Precambrian basement correlates approximately with the magnetic profile, although the sharp magnetic drop inside the rim is greater than expected on the basis of the moderate depth to basement.

Figure GS-13-3 (C-C') shows a subradial, north-south profile across the southeast end of the main granite rim outcrop on the southwest flank of the crater. The profile was run along a winter road. Results were completely unexpected, as the magnetic values show an irregular but progressive decrease from a point near the postulated limit of disturbance towards the crater rim, with the maximum rate of decline occurring immediately adjacent to the granite outcrop. Although no drill data are available along this profile, the magnetic values show no appreciable correlation with basement structure.

Magnetic readings taken at the site of hole M-3-82 show by far the lowest value recorded for the area (60 665 gammas), and are consistent with the drill results indicating a depth of more than 240 m to basement.

GS-14 STRATIGRAPHIC MAPPING AND CORE HOLE PROGRAM

by H.R. McCabe

The stratigraphic mapping and core hole program for 1982 involved a number of separate projects. A single drill hole was put down in northwest Winnipeg, beside a landfill site, to determine depth to bedrock and nature of bedrock strata. Further drilling was undertaken on the High Rock Lake structure to supplement last year's drilling, and additional geological mapping and ground magnetic profiling was carried out. A number of geologically interesting sites were evaluated as test sites for hammer seismic surveys by the Geological Survey of Canada, and drill locations were sited for these proposed seismic profiles. Five shallow core holes were drilled through thin Paleozoic cover in the area south of Cranberry Portage, to determine the source of a very high gradiometer anomaly outlined by recent Federal aeromagnetic surveys, and ground magnetometer profiles were run to outline specific drill targets. Finally, shoreline mapping was carried out on Clearwater Lake to evaluate the suggestion that the lake could reflect, in part, a meteorite impact structure.

Because of the more detailed nature of the study, the results of the High Rock Lake project are presented in a separate section (GS-13, this report). Core hole data are summarized in Table GS-14-1.

SEISMIC SURVEY PROJECTS

A group from the Geological Survey of Canada, under the direction of Dr. Jim Hunter, has been involved in a project to test a new "optimum window" reflection hammer seismic method for determining depth to bedrock (Hunter **et al**, 1982); they are also attempting to determine near-surface structure within the bedrock succession. The Manitoba Geological Survey submitted to the Geological Survey of Canada a total of six possible test areas where detailed seismic profiles, when combined with core hole data, could provide valuable geological information not otherwise attainable. Three of the proposed project areas were covered by seismic profiles this year, but no core holes have been drilled as yet on these profiles, (Fig GS-1).

A) GREENOAK PROJECT:

In the Greenoak area, approximately 50 km northeast of Winnipeg, a prominent Precambrian outcrop occurs in Sec. 3, Twp. 14, Rge. 8 EPM, only 5.6 km east of the easternmost known Paleozoic occurrence (from water well records). On the basis of regional structural data, the Precambrian surface appears to be structurally high by a minimum of about 30 m, but direct geological data are not available to determine the nature of this structure. Seismic profiles supplemented by core hole data may be able to define the structure within the Paleozoic succession, as well as the configuration of the Precambrian surface. This would test the suggestion by the writer (McCabe, 1980), that the Precambrian rocks in this area formed a paleotopographic high (emergent?) that exerted major control on the pattern of sedimentation during early Paleozoic (Winnipeg) time.

B) ARBORG (SYLVAN) PROJECT:

Cretaceous kaolin-silica sand deposits occur in Twp. 24, Rge. 1E, near the town of Sylvan, as channel-fill deposits deeply incised in the Paleozoic limestones. Diamond drilling of more than 140 test holes has only partially defined portions of the channel(s), which appear to be no more than 60-90 m across, but are in excess of 40 m deep (Bannatyne, 1967). Loop-frame electromagnetic profiles also have been run to aid in delimiting the channels. The seismic profiles may provide an alternative, or additional, tool for determining the size, shape and configuration of these deposits. Preliminary interpretations suggest the presence of several additional channel occurrences.

C) LAKE ST. MARTIN CRATER STRUCTURE:

Considerable work has been done on the nature and origin of the Lake St. Martin structure, a probable meteorite impact feature (McCabe and Bannatyne, 1970). Because of the lack of outcrop in the crater area. most geological information has been obtained from core hole drilling. Data are lacking, however, for most of the southern half of the crater, because thick overburden prevented core recovery. Seismic profiles may outline possible drill targets in this area, and may provide additional structural data within the Paleozoic strata of the uplifted rim and possibly within the complex crater fill. Preliminary interpretations suggest that complex internal structure can be outlined.

CRANBERRY PORTAGE PROJECT

Recent airborne gradiometer surveys by the Geological Survey of Canada (Weldon Bay-Goose Lake Area; G.S.C., Open File 756) show a prominent east-west trending curvilinear anomaly about 2.4 km south of the town of Cranberry Portage, and approximately coincident with the northern limit of sedimentary cover (Fig. GS-1). A total of five core holes were drilled to determine the nature of the anomaly and the nature and thickness of the Paleozoic cover.

In order to define the limits of the gradiometer anomaly more precisely on the ground, and to determine specific drill targets, a number of preliminary ground magnetometer profiles were run. These profiles and the locations of the profiles are shown in Figure GS-14-1. The main profile was run along the eastern edge of the road allowance for Highway 10. The reference point, station O-O is the intersection with Athapap Road, approximately 1920 m south of the north boundary of Township 64. A 50-foot (20 pace) spacing was used, as it appears to adequately define the anomaly, which consists of three separate peaks, increasing in magnitude from south to north, with a maximum reading of 64 000 gammas at 650 N. A large bedrock-floored area east of the highway provided an excellent drill site. A north-south profile was run through this area to determine the easterly continuation of the 650 N anomaly. The highest anomaly value in the cleared area (69 400 gammas) was located at 800 N, 235 E, and hole M-9-82 was drilled at this location. A second hole was located at 50 N, 75 E in a small borrow pit immediately east of the Athapap Road intersection, near the mid-point of the anomaly. A third hole, M-11-82 was located in the magnetically low area south of the anomaly, at 2140 S, 265 E.

In running the north-south profile through the site of hole M-9-82, a reversal in the expected northward drop-off was noted at the northern edge of the cleared area, but no indication of the extent of this high was evident on either the main north-south profile or the southwest-northeast profile run across the entire cleared area. Spot readings in this bush and swamp area showed apparently erratic magnetic readings with variations of 1000 gam-

TABLE GS-14-1
SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	System/ Formation/Member	Interval Metres	Summary Lithology
M-1-82	NW18-11-2E		0 - 8.13	Overburden
	+239.07 m	Ordovician-Stony Mountain		
		Gunton	8.13 - 10.82	Dolomite, buff, mottled
		Penitentiary	10.82 - 15.24	Argillaceous dolomite
		Gunn	15.24 - 35.36	Calcareous shale, limestone
		Red River-Fort Garry	35.36 - 43.21	Dolomite, buff, cherty (approx. 2 m limestone at top)
M-2-82	SE-14-34-28-2W	Ordovician-Stony Mountain		
	+245 m	Gunton	0.0 - 4.3	Dolomite, buff to purplish, brecciated
		Penitentiary/Gunn	4.3 - 17.3	Dolomite, argillaceous, mottled greyish red, disturbed
		Red River (?)	17.3 - 69.5	Brecciated dolomite, fine to coarse fragments, mixed Red River type lithologies (base disturbed section)
			69.5 - 115.4	Dolomite, buff to reddish mottled, massive, faint horizontal bedding
			115.4 - 117.0	Dolomite, reddish mottled, argillaceous interbeds, partly sandy, limonitic oolites
		Winnipeg	117.0 - 117.95	Sandy shale, medium grey, reddish streaks
M-3-82	1-9-29-2W	(High Rock Lake post-	0.0 - 14.0	Fossiliferous dolomite calcarenite, porous, massive
	+239 m	crater sedimentary	14.0 - 22.4	Dolomite, buff, dense, argillaceous and silty interbeds
		fill - Silurian?)		(dip approx. 15°)
			22.4 - 27.0	Sandy argillaceous dolomite, reddish mottled (20°)
			27.0 - 30.7	Dolomite, buff, mottled (15°)
			30.7 - 48.3	Red beds. Sandy silty argillaceous dolomite and dolomite shale
			48.3 - 54.8	Dolomite, slightly argillaceous, floating sand grains near base
		(crater fill breccia)	54.8 - 66.25	Microbreccia; mixed dolomite fragments to 4 cm
			66.25 - 246.2	Megabreccia; fine to coarse dolomite fragments to 20 m; some fragments sandstone and shale, trace granite
M-4-82	10-9-29-2W +238 M	(crater fill breccia)	0.0 - 51.1	Megabreccia, minor micobreccia, large "fragment" size, little stratigraphic mixing. Fort Garry lithology passes downward to Lower Red River to Winnipeg lithology
			51.1 - 60.7	Granite, moderately disturbed with sandy dolomite veinlets and zones of microbrecciation
M-5-82	19-9-29-2W	Ordovician-Stony Mountain		
	+234 m	Gunn/Penitentiary	0.0 - 20.5	Argillaceous dolomite, mottled reddish grey, "disturbed" (to 45°)
		Red River (?)	20.5 - 25.1	Microbreccia; buff dolomite fragments to 10 cm, sandy near base, some chert
		Winnipeg	25.1 - 48.1	Sandstone, poorly consolidated, medium well rounded grains, partly reddish argillaceous and ferruginous
		Precambrian	48.1 - 48.4	Highly weathered granite
			48.4 - 50.9	Granite, typical High Rock Lake type, "undisturbed"
M-6-82	9-9-29-2W +241 m	Ordovician (?)	0.0 - 62.0	Megabreccia, some microbreccia, numerous Lower Stony Mountain fragments
			62.0 - 72.8	Dolomite microbreccia
		Winnipeg	72.8 - 82.1	Sandstone, dolomite fragments in upper part, light grey with dark red mottling; poorly consolidated
		Precambrian	82.1 - 93.55	Granite, massive, typical High Rock Lake type. Upper 0.15 m weathered zone, 0.5 cm calcite veinlet
M-7-82	C14-34-28-2W +241 m	Ordovician (?)	0.0 - 115.0	Mixed microbreccia and medium to coarse megabreccia, highly mixed with numerous fragments Lower Stony Mountain (except top 21.7 m)

TABLE GS-14-1
SUMMARY OF CORE HOLE DATA

Hole No.	Location and Elevation	System/ Formation/Member	Interval Metres	Summary Lithology
			115.0 - 123.8	As above but no admixed Lower Stony Mountain
		Winnipeg (?)	123.8 - 124.2	Sandstone, some dolomite fragments
M-8-82	NW14-34-28-2W +243 m	Ordovician (?)	0.0 - 62.6	Mixed microbreccia and megabreccia, dominantly microbreccia, fragments of Lower Stony Mountain common
			62.6 - 90.9	As above but no admixed Lower Stony Mountain (base disturbed section)
		Red River	90.9 - 115.5	Dolomite, massive, buff mottled to reddish mottled in basal 6 m (0°)
		Winnipeg	115.5 - 118.3	Shale and sandy shale, mottled medium light greyish red
M-9-82	NW16-19-64-26W +304 m (800N,235E)	Ordovician-Red River	0.0 - 2.85	Dolomite, pale yellowish brown, mottled, massive
			2.85 - 5.48	Dolomite with floating sand grains grading down to dolomitic sandstone, prominent dark purplish grey mottling, fossiliferous *(Receptaculites)*
		Precambrian	5.48 - 6.4	Dark olive brown clay (weathered zone?)
			6.4 - 12.31	Very fine grained magnetite-quartz iron formation with minor/trace epidote, chlorite and feldspar; banding at ±30° to core axis. Minor pyrite, trace chalcopyrite, fine calcite veins.
M-10-82	SW16-19-64-26W		0.0 - 1.45	Overburden
	+304 m (50N, 75E)	Ordovician-Red River	1.45 - 4.8	Dolomite, pale yellowish brown, faintly mottled, massive
			4.8 - 8.35	Dolomite with floating sand grains at top grading down to dolomitic sandstone, in part prominent purplish mottling, pyrite
		Precambrian	8.35 - 14.45	Lost core. Weathered zone?
			14.45 - 26.3	Very fine grained, foliated magnetite-quartz-chlorite iron formation with coarse grained hornblende, chlorite, epidote, hornblende/biotite, chlorite/epidote, chlorite/magnetite and hornblende-rich layers
M-11-82	NW8-19-64-26-W		0.0 - 2.15	Overburden
	+306 m (2140S, 265E)	Ordovician-Red River	2.15 - 6.75	Dolomite, buff, mottled
			6.75 - 8.43	Sandy dolomite grading to dolomitic sandstone at base
		Precambrian	8.43 - 8.65	Weathered granite; coarse grained homogeneous pink granite with scatted pyrite aggregates
M-12-82	SW1-30-64-26W	Ordovician-Red River	0.0 - 2.3	Dolomite, buff, mottled
	+304 m		2.3 - 5.06	Sandy dolomite grading down to dolomitic sandstone
	(885N, 150E)	Precambrian	6.2 - 7.95	Magnetic metasediment to iron formation with magnetite/quartz/chlorite layers alternating with blue-green amphibole-rich layers.
M-13-82	SW1-30-64-26W	Ordovician-Red River	0.0 - 5.5	Dolomite, buff, mottled
	+304 m (890N, 150E)		5.5 - 10.3	Dolomite with floating sand grains grading down to dolomitic sandstone at 7.0 m
	(Inclination 30° N)	Precambrian	10.3 - 14.5	Weathered zone
			14.5 - 21.5	Fine grained, foliated quartz-epidote-magnetite iron formation with coarser grained epidote, chlorite/magnetite, biotite/magnetite, and hornblende/magnetite-rich layers; epidosite layers with disseminated magnetite, and magnetite-rich siltstone with 0.2 - 0.5 cm epidosite clots representing altered felsic fragments/plagioclase phenocrysts.

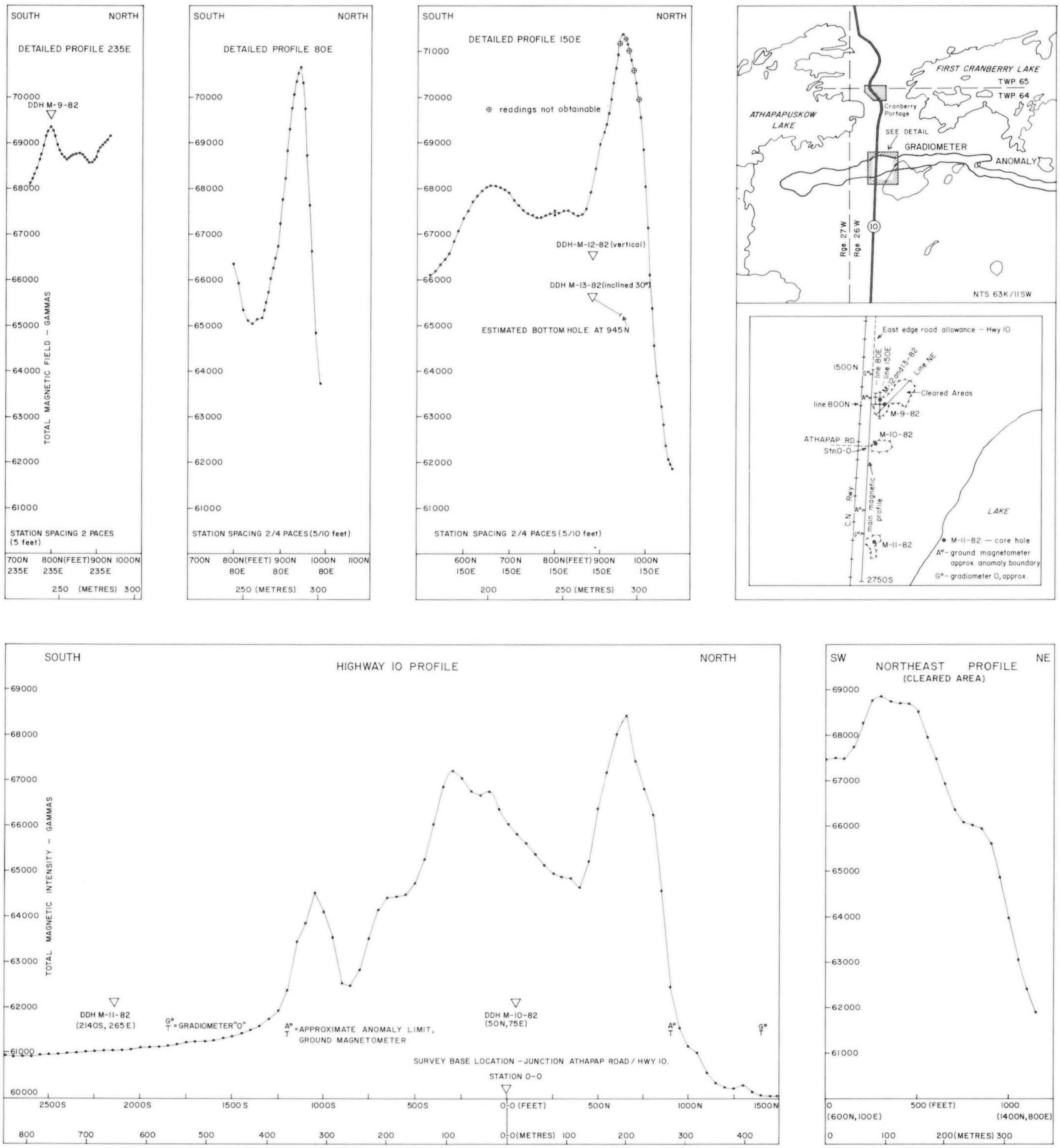

Figure GS-14-1: Cranberry Portage Area - Ground Magnetometer Profiles.

mas and or more over a few metres. At many places the instrument could not provide a valid reading, presumably because of the excessive magnetic gradient. To clarify the picture, two detailed north-south profiles were run on 5-foot (two pace) spacing. Lines were run visually because compass deviation of up to 30° had been noted. Results of the 80 E and 150 E lines are shown in Figure GS-14-1. The 5-foot spacing outlined a sharply defined anomaly 20-30 m wide at 940-950 N, with a maximum (attainable) reading of 71 300 gammas, and this through a Paleozoic cover of approximately 5 m. The magnetic gradient on the north flank of the anomaly exceeds 650 gammas per metre.

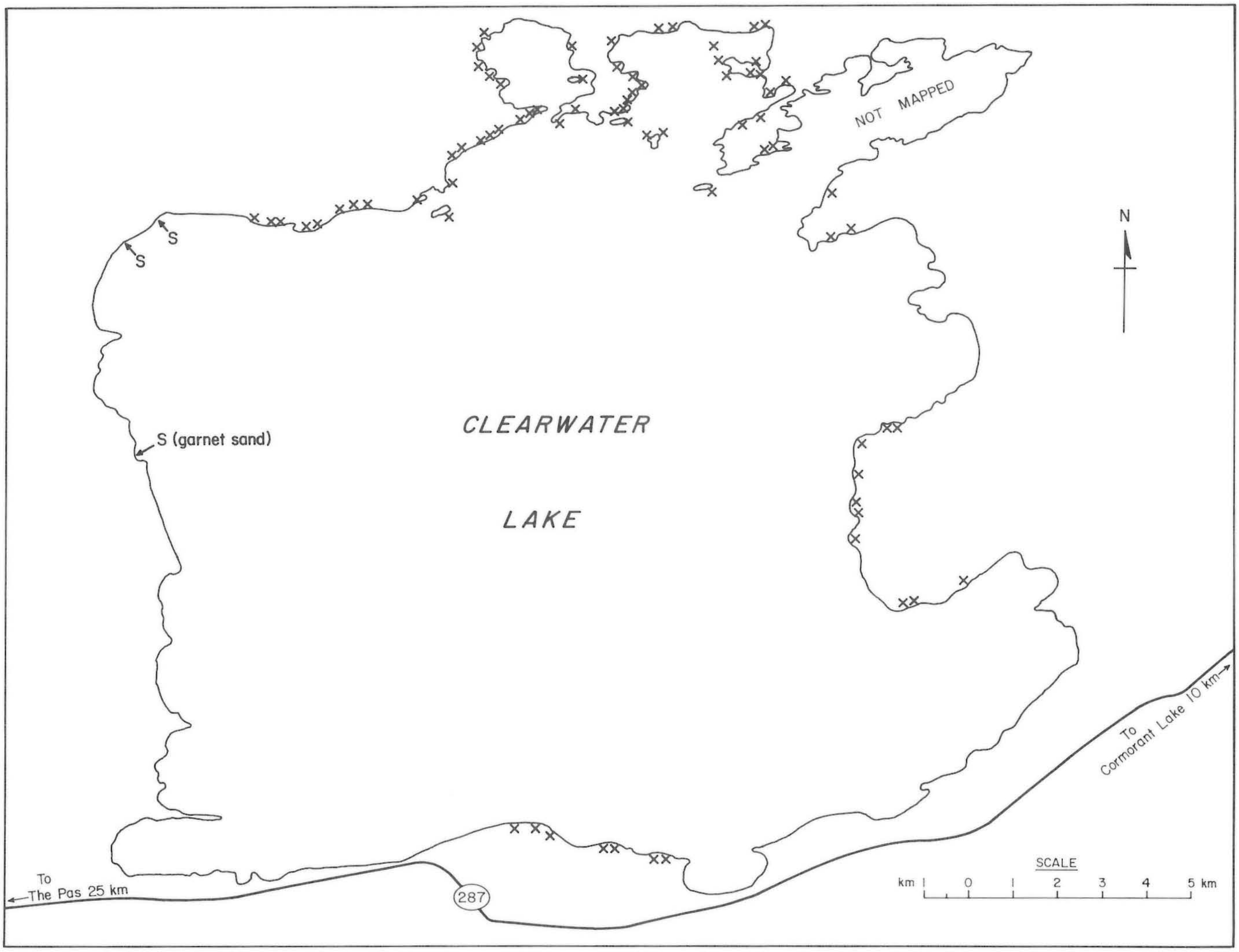

Figure GS-14-2: Clearwater Lake Area - Outcrop Localities.

To check the above anomaly, the drill rig was moved as close as possible to the anomaly (88 N, 150 E). A vertical hole, M-12-82, was put down at this point, and a second hole, M-13-82 was drilled at an inclination of 30° north, to a "depth" of 21.15 m. This represents a calculated bottom hole position of 945 N, at a true vertical depth of 10.5 m. This should have been sufficient to intersect the main anomaly zone, especially since indications are that the Precambrian dips to the south at about 70°. (The vertical core holes show banding inclined at 70°, and the configuration of the individual and overall anomaly patterns suggest a southerly rather than a northerly dip.).

Paleozoic thicknesses in the test holes range from 5 m in the north to 8.4 m in the south, reflecting the normal gentle southward thickening expected on a regional basis. The strata consist of dolomite and sandy dolomite of the Ordovician Red River Formation. The upper beds are finely crystalline, moderately granular mottled dolomite typical of the northern facies of the Red River. The basal 1.68 to 2.76 m consists of a well defined sandy unit, ranging from a sandy dolomite at the top, with medium, rounded quartz grains floating in dolomite, grading downward to a very sandy dolomite or dolomitic sandstone at the base. The lower part of this unit shows prominent dark grey to purplish rim-like mottling, due largely to the presence of very fine grained pyrite. One well-preserved specimen of **Receptaculites**, a characteristic Red River fossil, was found in the sandy zone. Despite the very sandy nature of the basal Paleozoic beds, the dolomite content and especially the occurrence of **Receptaculites** strongly suggest that these sandy beds represent a basal (transgressive?) sandy facies of the Lower Red River Formation, rather than Winnipeg Formation. There was no indication at the base of the Paleozoic section of any underlying shale on non-dolomitic sandstone that might represent true Winnipeg Formation. The contact with the Precambrian is sharp, with little evidence of any appreciable content of locally derived basement detritus.

Core for the magnetite-bearing Precambrian rocks is under investigation.

CLEARWATER LAKE PROJECT

The occurrence of relatively deep holes in the lake bottom near the north shore of Clearwater Lake, along with the occurrence of highly garnetiferous sands, and the approximately circular configuration of the lake have given rise to the suggestion that the lake could, in part, represent a meteorite impact structure. Six outcrops have been reported along the south and east shores of the lake (Stearn, 1956), but none were known to occur along the north shore. A one-day reconnaissance trip was made to determine if additional outcrops were present and to ascertain if there was any evidence of structural deformation attributable to meteorite impact.

Appoximately 50 "new" outcrops were located, scattered along almost the entire length of the north shore of the lake (Fig. GS-14-2). All occurrences appear to be normal, flat-lying, with no evidence of brecciation, anomalous dips or unusual lithologies. The exposures are believed to comprise an approximate strike section of Upper Ordovician strata (Upper Stony Mountain and/or Stonewall). No geological evidence was seen suggestive of a meteorite impact structure.

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GS-15 OVERBURDEN SAMPLING IN THE LYNN LAKE AREA

by Erik Nielsen

Detailed till sampling was undertaken around the Agassiz Mine situated approximately 7 km northeast of Lynn Lake to test the feasibility of using overburden, specifically till, as a medium for low cost geochemical prospecting. The study area (approximately 14 km²) is situated between the Agassiz Mine and Highway 391 (Fig. GS-15-1).

The site was chosen because:

1) the northeasterly striking deposit which measures approximately 1400 x 30 m outcrops at the surface and should have been a good point source and left an easily detectable dispersion fan in the down ice direction,
2) the ice flow direction varies little throughout the area,
3) the stratigraphy of the Quaternary sediment appears to be relatively simple,
4) the regional bedrock geology has been mapped (Gilbert **et al.**, 1980), and
5) access to sampling sites down ice from the deposit is good.

ICE FLOW DIRECTION

Although the maximum relief is about 55 m (170 ft.) the area is dominated by hills with local relief less than 20 m (65 ft.). These hills are generally less than 1 km long and somewhat narrower. The long axes of the hills are orientated approximately 200°. Striations in several places are parallel to the strike of inclined bedrock surfaces. At other sites striae on the hilltops trend towards 190° whereas on the northwest flanks of the hills they trend toward 200° indicating a topographic influence on the ice flow pattern.

Striation directions measured at 24 sites elsewhere in the Lynn Lake region vary between 182° and 210°. At one site near Zed Lake older striae trending 184° are truncated by a later ice flow striking towards 214°.

Striae were measured at 12 sites within the study area and vary between 180° and 226°. Age relations of striae recorded at three locations indicate early ice flows were towards 192°, 188° and 196° followed by ice flow towards 220°, 218° and 210° respectively (Fig. GS-15-2). The consistent change in the striae direction from southerly to west of south as recorded at these sites is due to a change in the ice flow direction rather than due to any topographic effect. The shift towards more westerly ice flow was probably due to the increased influence of Labradorean ice in northeastern and north-central Manitoba during the late Wisconsinan (Nielsen **et al.**, 1981).

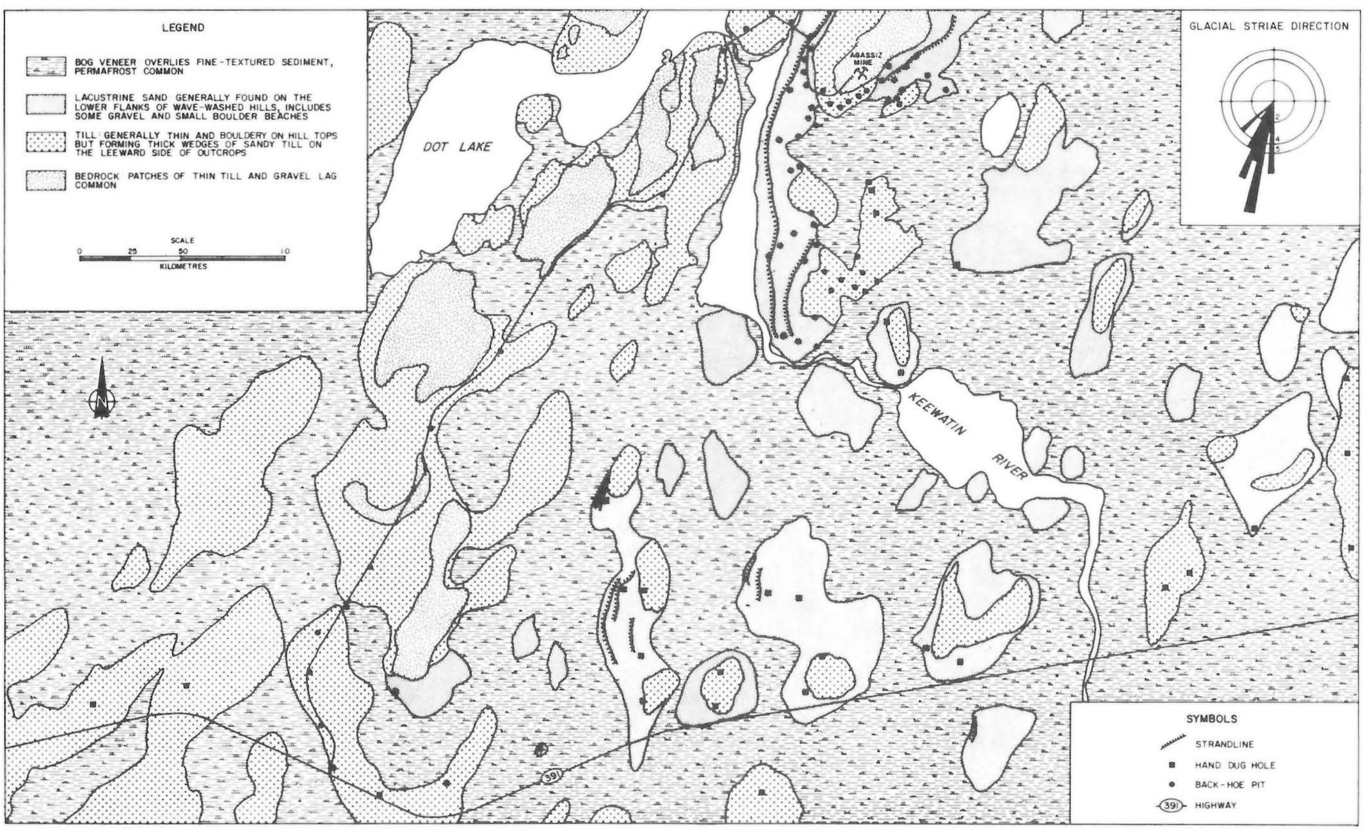

Figure GS-15-1: Surficial geological map of the Agassiz Mine area.

Figure GS-15-2:

The ice flow directions near the Agassiz Mine. Note the more intense discolouration on the older surface with striations towards 196°.

QUATERNARY STRATIGRAPHY

Thick till wedges have been developed on the lee side of bedrock hills which obstructed the ice flow. Crag-and-tail hills thus account for much of the preserved till in the area.

The till is pinkish grey in colour (5YR 8/1) and generally sandy in texture having been derived from the comminution of mafic and intermediate volcanic rocks which underlie the area and of granite and granodiorite which occur extensively to the north.

The till is extensively wave-washed and a boulder lag is commonly present on the hilltops. Along the flanks of the hills the till is overlain by littoral sand which has been winnowed from the surrounding hills. The sand is well sorted and attains thicknesses greater than 2 m on the lower flanks of the hills. The sand usually directly overlies the till, although deep-water Lake Agassiz clay was encountered below the sand in several places.

Strandline deposits are conspiciously absent although there are several prominent erosional terraces between 335 m and 350 m (a.s.l.).

The sandy nearshore deposits grade laterally into finer textured sediments which underlie the extensive low areas of bog veneer.

SAMPLING

Till sampling was concentrated on the down ice or lee side of hills. Of the 95 holes, 33 were dug by hand and 62 were dug by backhoe, 65 holes were on the lee side, 16 holes were on the stoss side and 14 holes were either on the top of the hills or in a position which was difficult to classify. Till was encountered in 91 holes and bedrock was encountered in 54 holes.

An approximately 20-litre sample of each major unoxidized lithosome was collected from each of the 33 hand dug holes, whereas 40-litre samples were collected from the backhoe pits. The 40-litre samples were subsequently split and a 20-litre portion stored. The stages in the preparation of heavy mineral concentrates from the till is illustrated in Figure GS-15-3. The samples will be analyzed for copper, lead, zinc, nickel, antimony, silver, arsenic and gold.

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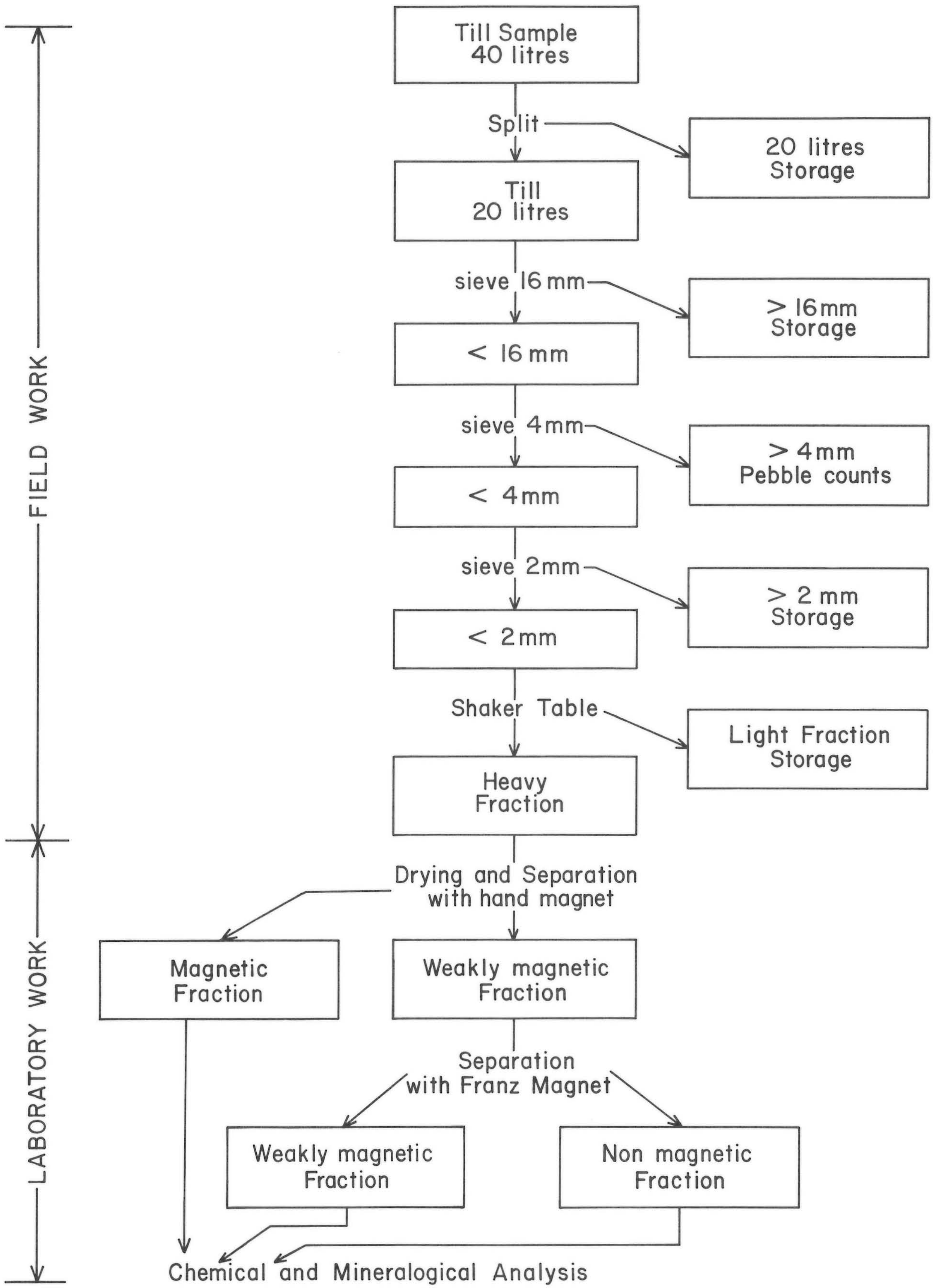

Figure GS-15-3: Flow sheet illustrating the sample processing procedure used for this study.

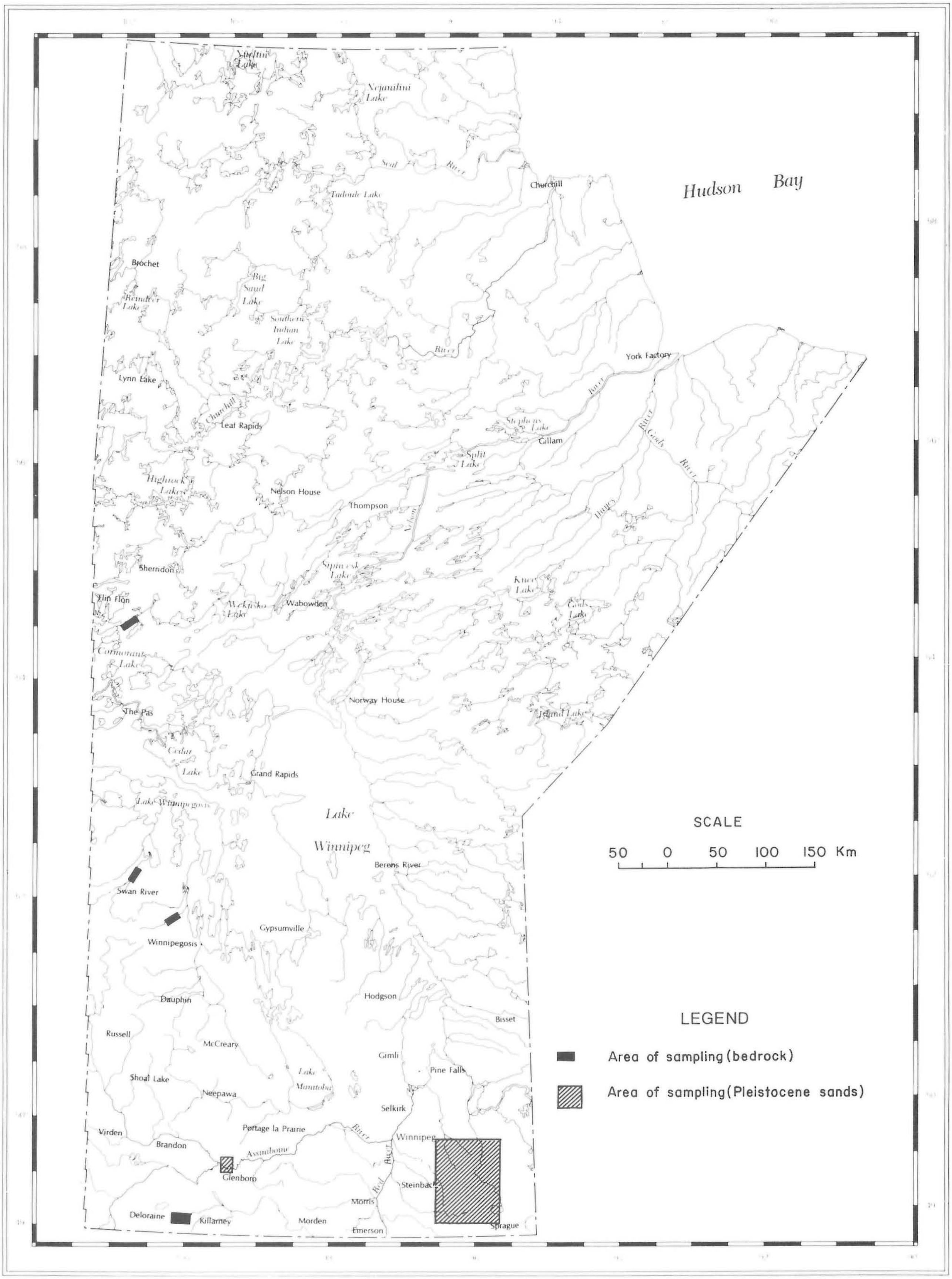

Figure GS-16-1: Location of areas investigated - 1982 field season.

GS-16 SILICA IN MANITOBA

by David M. Watson

INTRODUCTION

During the first year of this project, silica occurrences in southern Manitoba were sampled (Watson, 1981). During this, the second year, silica samples were collected from deposits ranging from Churchill to Boissevain, and from Swan River to the Whiteshell (Fig. GS-16-1).

Preliminary examination of the samples in the field indicates that aside from some of the sandstone in the Swan River area, and the Churchill quartzite, there are very few silica deposits in the province that are worth consideration (excluding the Winnipeg Sandstone which is already being exploited on Black Island).

Laboratory work done to date includes sieve analysis of unconsolidated sands and friable sandstone. These results are reported in Table GS-16-1. Chemical analyses reported in Table GS-16-2 include analyses on samples recently collected, and previous reported analyses from the same locations.

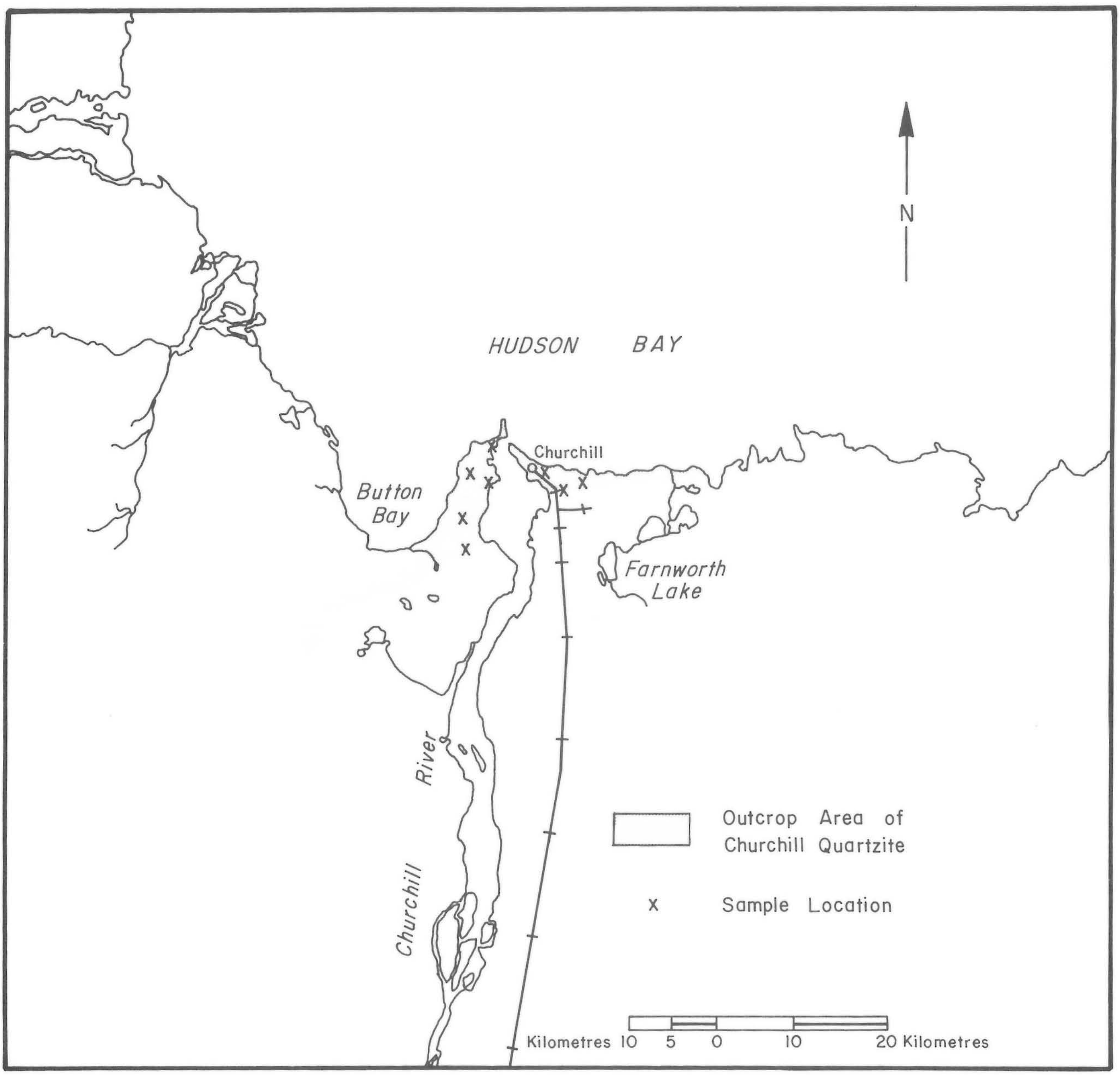

Figure GS-16-2: Churchill area - showing distribution of quartzite and sample locations.

TABLE GS-16-1
Chemical Analysis

LOCATION	SiO_2	Fe_2O_3	Al_2O_3	CO_2
Churchill*	97.65	0.73	0.98	0.12
Pine River*+ (Swan River Formation)	99.71	0.027	0.036	
Boissevain*	38.82	3.01		23.88
Richer* (Pleistocene)	77.5	1.1	7.78	3.46
Libau (Pleistocene)	87.2	0.9	6.52	0.17
Marchand (Pleistocene)				

TABLE GS-16-2
Sieve Analysis

LOCATION	20	40	50	70	100	200	pan
Churchill*				NOT DONE			
Pine River*+ (Swan River Formation)	10.5	8.5	9.0	18.0	25.0	19.5	6.5
Boissevain*	0.9	2.2	3.1	16.4	47.7	24.0	5.6
Richer* (Pleistocene)	0.0	0.2	4.6	13.4	44.7	15.2	23.1
Libau (Pleistocene)	0.0	5.9	27.4	48.7	11.8	7.2	0.1
Marchand (Pleistocene)	0.0	0.6	4.5	23.5	40.7	28.5	2.2

* from Mineral Resources Division files.
\+ washed sample.

GEOLOGY OF THE DEPOSITS

1) Churchill Quartzite

The Churchill quartzite occurs as a series of low ridges along the shore of Hudson Bay both to the east and west of Churchill. The outcrop belt extends about 15 km along the coast on each side of town, and also to the west on the west side of the Churchill River (Fig. GS-16-2).

The quartzites, comprise proto and orthoquartzites (Schledewitz, 1977) containing quartz with minor amounts of sericite, chlorite and hematite. The cement is also siliceous. The silica content varies, but in places reaches 98%. Due to the well cemented nature of the rock, no attempt was made to produce a screen analysis. Some chemical analyses of samples collected by Schledewitz are given in Table GS-16-1.

2) Swan River Formation

The occurrence of silica sand in the area of Swan River was first reported by Tyrrell (1893). Since that time, interest has also been shown in the clays and lignite that are found with the sand. The occurrence on Pine River has had the most work done on it. This includes several pits and shafts that were put down to investigate the lignite.

The silica sand outcrops on the banks of the Pine and Swan Rivers. In both locations the sand is unconsolidated, horizontally bedded and uniform in composition throughout the exposure. There is no iron staining nor signs of impurities aside from small amounts of clay. The samples collected were screened, and results are given in Table GS-16-1. The chemical analyses are for samples collected in 1963 by B. B. Bannatyne of the Manitoba Department of Energy and Mines.

3) Boissevain Formation

The Cretaceous Boissevain Formation outcrops at several locations in the area south of Boissevain. The occurrences are all limited to small exposures in gullies and on stream banks. During the early part of the 1900's, several quarries were operated for building stone. These quarries are all now either filled in or, in one case, under the new reservoir for the town.

Where examined, the sandstone is well bedded, friable and cut by numerous joints and fractures. The sand is usually weathered to a loose sand containing a few better cemented lumps. Unlike the Swan River and Winnipeg sands, this material contains many impurities of mica and iron bearing minerals. The sieve analysis is given in Table GS-16-1, and the chemical analysis in Table GS-16-2.

4) Pleistocene to Recent

Various deposits of Recent sands were sampled. These included sands from Pleistocene glaciofluvial and recent beaches. In general these sands are impure and cannot be classed as silica sand nor even silica-rich sands. Although many of the sands could be upgraded to silica sand, the economic restraints on such an operation make them not worthy of further study at this time although they may be useful for concrete, traction sand or uses requiring less pure material. The chemical analyses and sieve analyses of these samples are given in Tables GS-16-1 and GS-16-2, respectively.

SUMMARY

With the exception of the Swan River sands and the Churchill Quartzites, none of the potential sources of silica sampled this season met the grade as far as chemical and physical requirements for glass sand are concerned. Churchill Quartzites may have potential as a source of lump silica, and the Swan River material has already been shown to be capable of being upgraded to glass grade.

Complete chemical analyses and physical properties along with the geology and economic potential of these and the other deposits described last year, will be published in 1983.

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GS-17 AIRBORNE VERTICAL GRADIENT MAGNETOMETER (GRADIOMETER) SURVEYS IN THE McCLARTY LAKE AND LYNN LAKE AREAS

by W.D. McRitchie and I. Hosain

Gradiometer surveys in 1982 were conducted by the Geological Survey of Canada (Regional Geophysics and Geochemistry Division) in both the Flin Flon/Snow Lake region and at Lynn Lake, as part of jointly funded Federal/Provincial mineral initiatives in northern Manitoba. The objectives of the gradiometer program in the Flin Flon/Snow Lake area were reviewed by McRitchie and Hosain (1981); progress to date is summarized in Table GS-17-1.

TABLE GS-17-1

Gradiometer Surveys in Manitoba 1980-1982

Project Designation	Total line km	Year Flown	Publication	Release Date
Weldon Bay/ Goose Lake	10 000	1980	G.S.C/ Open File 756	(Project Comorant) June 30, 1981
Iskwasum Lake	7 900	1981	G.S.C. Open File 877	(Project Comorant) Oct. 27, 1982
McClarty Lake	12 000	1982	G.S.C. Open File	(Project Comorant) March, 1983
Sherridon/ Heming Lake	3 700	1981	G.S.C./ Open File 876	Oct. 27, 1982
Lynn Lake area	4 000	1982	G.S.C. Open File?	Nov., 1982?

In 1982 surveys were flown over McClarty Lake (12 000 line km) completing coverage for the northern half of the Project Cormorant test area. A total of over 30 000 line km have now been flown at a line spacing of 305 m and aircraft mean altitude of 152 m (Fig. GS-17-1). Extreme diurnal activity during the summer of 1982 resulted in cancellation of the total field measurements, however, gradiometer responses were recorded for both this and the Lynn Lake area together with VLFEM data.

A pilot study near Lynn Lake (4 000 line km) (Fig. GS-17-2) was implemented to see whether the gradiometer could provide more accurate control on the geology than was possible using the magnetic data from the earlier Questor surveys (1976 and 1977). Extensive drift cover has always precluded the development of a definitive geological map for the Lynn Lake area and even small gains resulting from the application of the new instrumentation should be of substantial value to mineral exploration in this region.

Copies of the GSC Open Files can be obtained at the user's expense from Campbell Reproductions, 880 Wellington Street, Ottawa, Ontario K1R 6K7. Digital magnetic tapes containing the edited recorded data and gridded aeromagnetic data are available from the Geological Survey of Canada, Room 567, 601 Booth Street, Ottawa, Ontario K1A 0E8 at the user's expense on a cost recovery basis.

The assistance and co-operation received from A. Darnley and P.J. Hood (GSC) in arranging for and implementing the surveys is gratefully acknowledged.

REFERENCES

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OF 756 — Weldon Bay-Goose Lake Manitoba
OF 876 — Sherridon — Manitoba
OF 877 — Cormorant (Iskwasum) Lake — Manitoba

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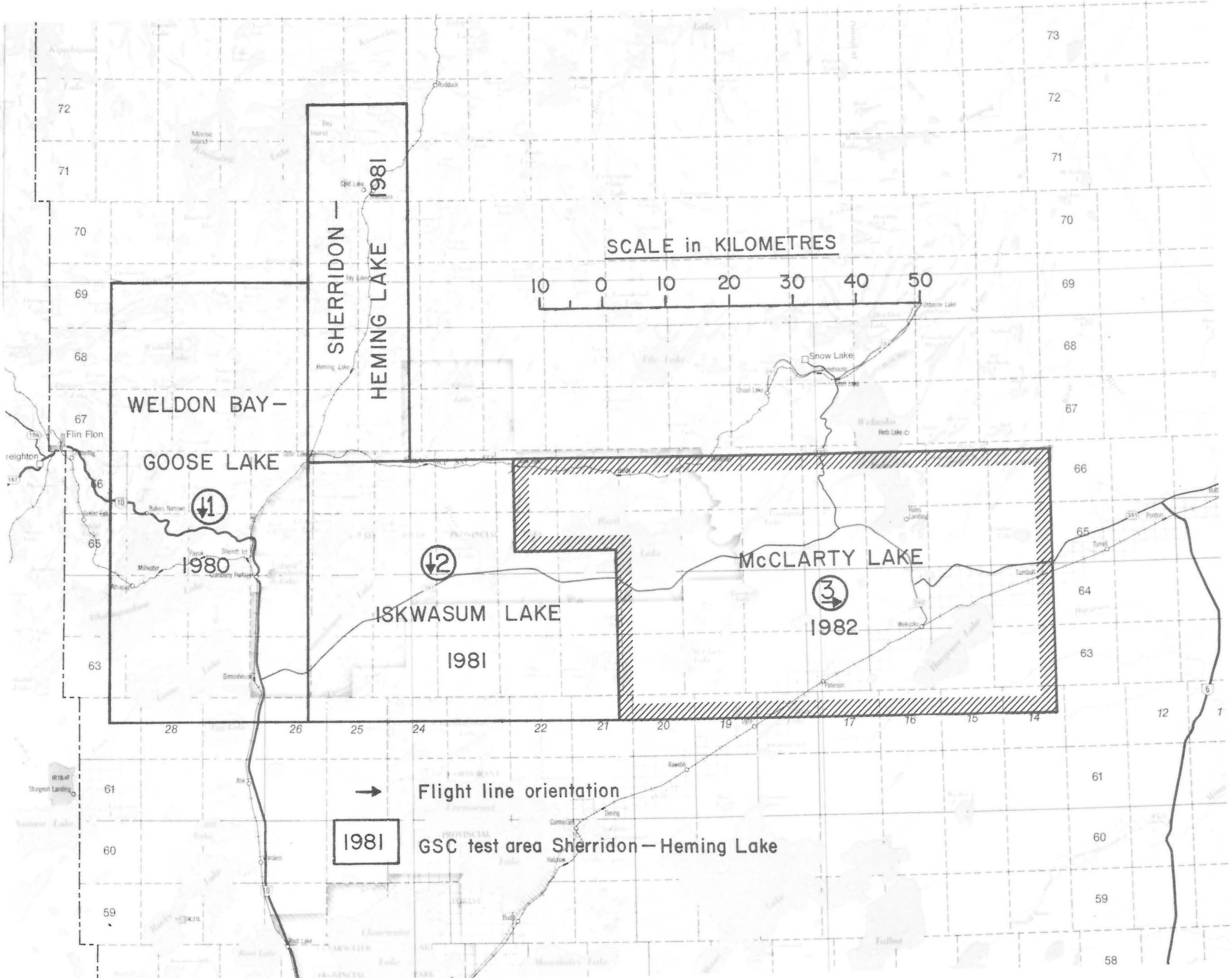

Figure GS-17-1: Aeromagnetic gradiometer surveys in the McClarty Lake area.

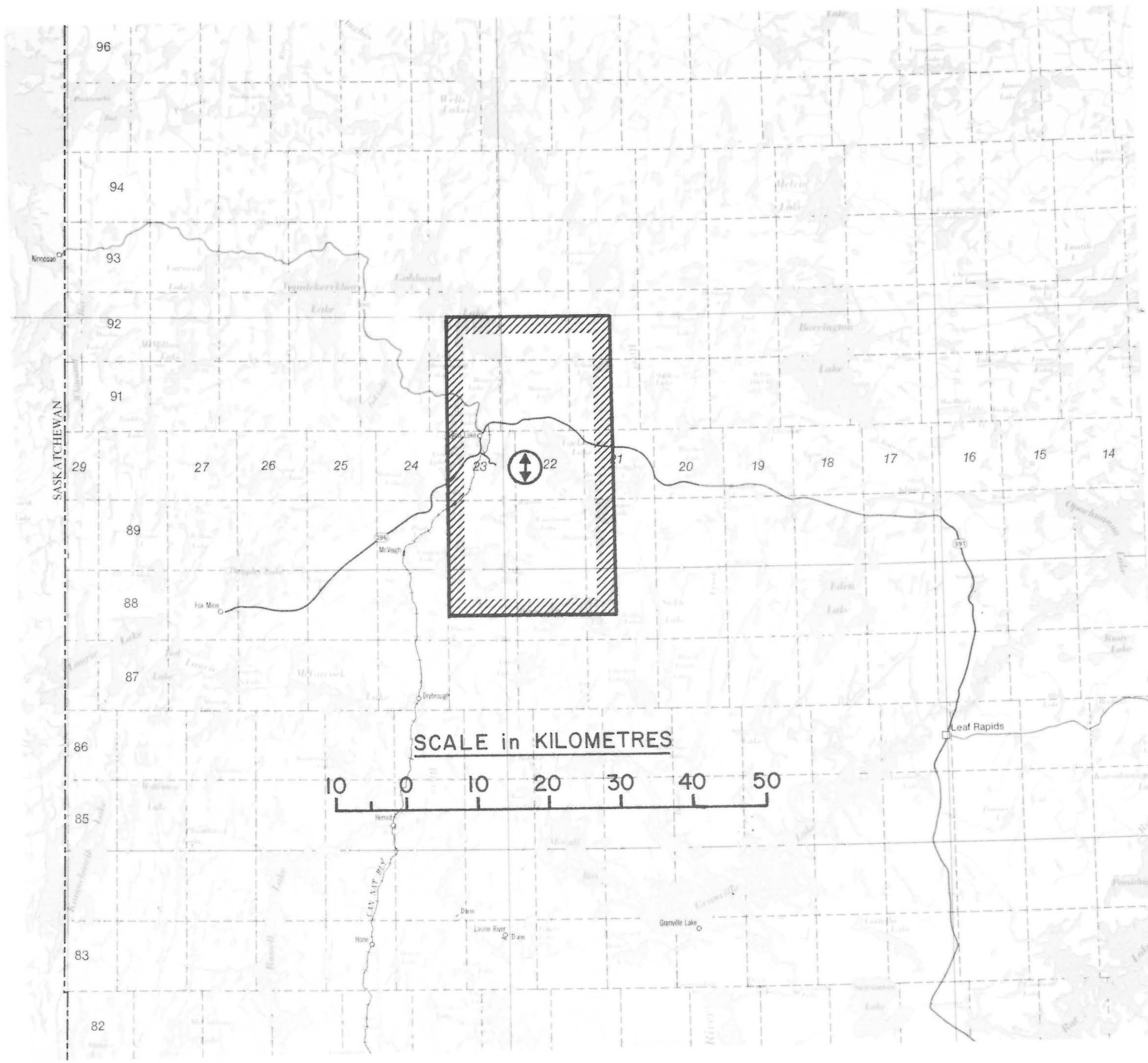

Figure GS-17-2: Aeromagnetic gradiometer survey in the Lynn Lake area.

MINES BRANCH

AGGREGATE RESOURCES SECTION

AR-1 BEDROCK AS AN AGGREGATE SOURCE IN THE CHURCHILL AREA

by R.V. Young

A sand and gravel inventory of the Churchill area was previously conducted to assess existing reserves and to determine the quality of granular deposits. Natural constraints to transportation and ready access such as Churchill River, numerous small lakes, swampy terrain and high water table were found to limit sand and gravel extraction. Accessible reserves of high quality sand and gravel are estimated at only 156 000 cubic metres. Local bedrock outcrops were therefore evaluated as readily accessible sources of crushed stone, an alternate source of sand and gravel. Selected engineering tests were performed on bedrock samples to simulate mechanical and chemical weathering as indicators of the suitability of the bedrock for crushed stone.

REGIONAL BEDROCK

Bedrock in the Churchill area is confined to the ridge-like outcrops west of Churchill River and along the shore of Hudson Bay (Fig. AR-1-1). Along Hudson Bay coastline at Churchill, Bostock (1969) noted steeply dipping Precambrian subgreywackes, consisting of quartzite, conglomerate and siltstone, outcropping through horizontal to gently dipping Paleozoic Severn River Formation dolomitic limestone. Inland from Hudson Bay, the Paleozoic bedrock comprises the Silurian Severn River Formation and the Upper Ordovician Churchill River Group, the geological contact being east of Churchill River.

The most recent geological investigation was conducted by Schledewitz (1977) west and east of Churchill River. The Paleozoic Severn River Formation was not observed in outcrop and was not mapped. Schledewitz interpreted the subgreywacke as a series of interlayered protoquartzites and orthoquartzites and termed the bedrock Churchill Quartzite.

SAND AND GRAVEL RESOURCES

Sand and gravel resources were previously described by Nielsen and Young (1981). The sand and gravel deposits are either prominent beach ridge or regressive shoreline deposits. The beach ridge deposits are former Tyrrell Sea beaches 1-3 m high, 50-150 m wide, and often extend up to 6 km in length. The tops of the beaches are generally flat with minor successive strandlines along the sides of the ridges. The shoreline deposits form a discontinuous mantle over much of the area and exhibit minimal relief.

The texture of the sand and gravel varies from fine sand to cobbly coarse pebble gravel. The structures are variable ranging from massive to horizontal bedding. The 4 to 16 mm clasts are predominantly subrounded. Pebble lithologies vary from 64-100 per cent carbonate with secondary Precambrian clasts.

BEDROCK AS AN AGGREGATE SOURCE

A total of five bedrock samples (Fig. AR-1-2) were tested. Tests selected were based on specifications from the American Society for Testing and Materials (A.S.T.M.), the Canadian Standards Association (C.S.A.), and from data supplied by local contractors and engineering firms. Specific tests included:

1. Los Angeles abrasion, which is a measure of the abrasive resistance of the bedrock.
2. Sodium sulphate soundness, which is designed to simulate resistance to disintegration.
3. Absorption, which is a measure of the increase in weight of a porous solid body resulting from penetration of a liquid into the rock.

Figure AR-1-1: Churchill Quartzite exposure with littoral sand and gravel in foreground.

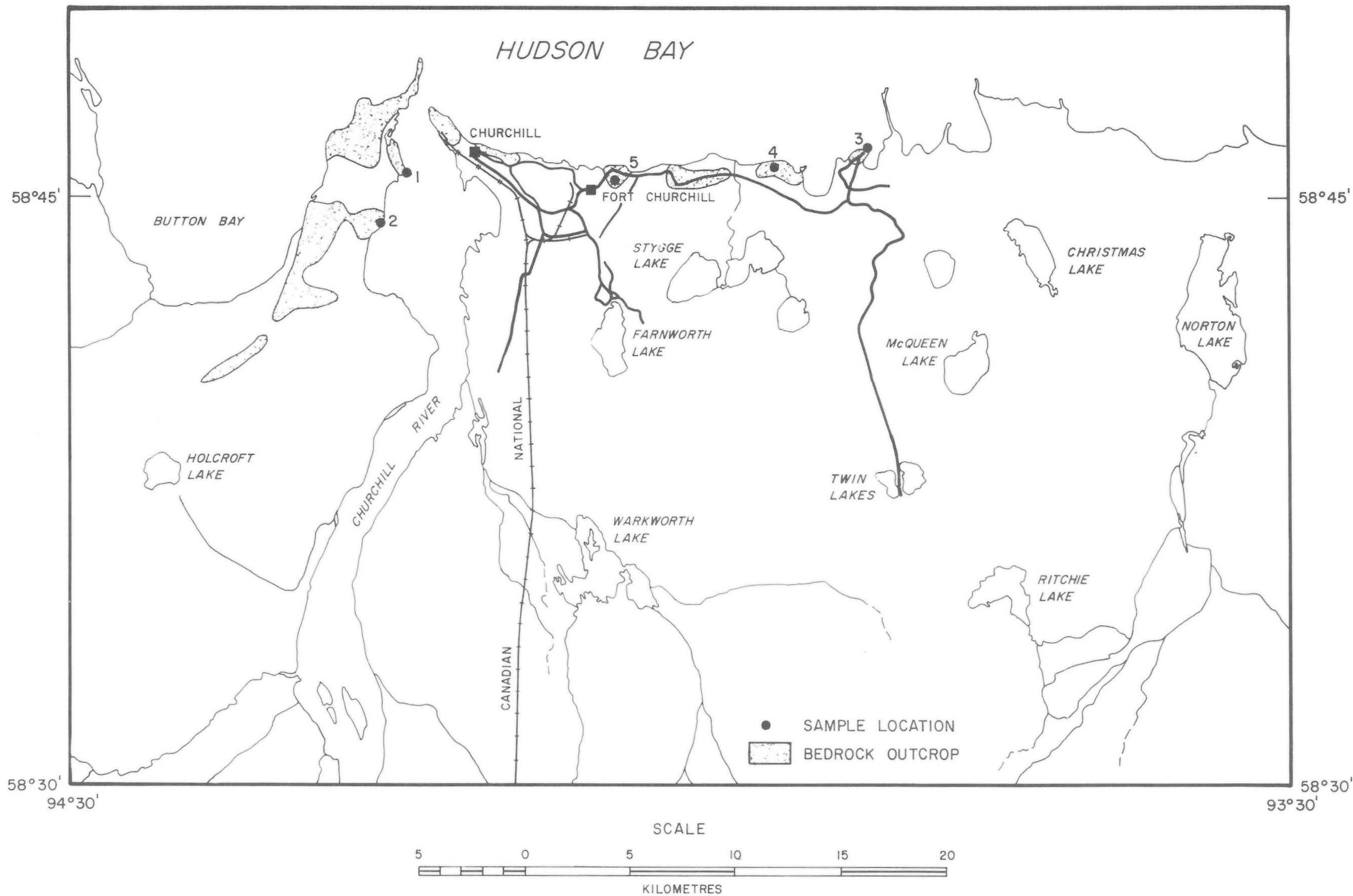

Figure AR-1-2: Bedrock outcrops and sample locations.

TABLE AR-1-1

MAXIMUM VALUE ENGINEERING TEST REQUIREMENTS

OF AGGREGATE DERIVED FROM CRUSHED BEDROCK

TEST	BASE COURSE CLASS A	BASE COURSE CLASS B	TRAFFIC TYPE A	BITUMINOUS CLASS A	CONCRETE FINE	CONCRETE COARSE	BALLAST	TERRAZO AGGREGATE
Los Angeles Abrasion % Loss	60		35	35		50 40 35(1)	40	25
Sodium Sulphate Soundness % Loss				12	16	12	10	6
Absorption – %				1-2	1-2		0.5-1.0	
Shale – %	15	5	15					
Fineness Modules					2.3 to 3.1			

(1) The abrasion loss shall not be greater than 35 per cent when aggregate is used in concrete paving or for other concrete surface subjected to significant wear.

The Aggregate Resources Section developed Table AR-1-1 which summarizes some of the engineering specifications for various end uses of crushed stone. Included within the table is the percentage shale which is the allowable percentage deleterious material, and fineness modules which is an empirical factor of coarseness or fineness of aggregate relating the amount of water and cement that must be used in producing a workable mixture of concrete.

TEST RESULTS

Test results are summarized in Table AR-1-2. Test results for samples 82-1, 82-2, 82-3 and 82-5 are consistent and indicative of a sound durable rock. The samples crushed into fairly equiangular pieces indicating that these rock units are massive. Visually, these four samples appear durable and competent. The bedrock outcrops represented by these four samples would be acceptable sources of crushed rock for all applications including base course, traffic bituminous, concrete, ballast and terrazo aggregate.

Sample 82-4 has nearly twice the abrasion loss, absorption, porosity and soundness loss of the other samples. It also has a lower bulk specific gravity and produces more flaky particles when crushed. Visually the sample appears to be less well indurated than the other samples, and this may be primarily responsible for the higher abrasion loss. Even though this sample's performance is poorer than the other samples, it could be acceptable for all end uses, although the high abrasion loss may be a concern for some of these applications. It would not likely be considered for use as ballast.

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1981: Quaternary Geology and Aggregate Resource Inventory of the Thompson and Churchill Areas; **in** Manitoba Department of Energy and Mines, Mineral Resources Division, Report of Field Activities 1981, p. 103-106.

Schledewitz, D.C.P.
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TABLE AR-1-2

Test	Sample Number 82-1	82-2	82-3	82-4	2-5
Los Angeles Abrasion Loss	26.8%	22.7%	23.6%	41.6%	27%
Bulk Specific Gravity	2.690	2.694	2.681	2.660	2.686
Bulk Specific Gravity (Saturated Surface Dry Basis)	2.698	2.703	2.691	2.679	2.697
Apparent Specific Gravity	2.711	2.718	2.708	2.713	1.716
Absorption	0.3%	0.3%	0.4%	0.7%	0.4%
Porosity	0.8%	0.9%	1.0%	1.96%	1.1%
Soundness Loss	0.2%	0%	0%	0.6%	0.1%/0.4%

AR-2 SURFICIAL GEOLOGY OF THE DELTA MARSH AREA

by Phyllis Mitchell

Surficial geological mapping of the Delta Marsh area was carried out during the summer of 1982 to complete the mapping of the northern portion of the R.M. of Portage la Prairie. The study area lies between Lake Manitoba and latitude 50°00′ N and between longitudes 98° 34′ W and 97° 52′ W. In the east it extends as far south as latitude 49° 48′ N. (Fig. AR-2-1). The southern portion of the R.M. of Portage la Prairie was mapped in 1978 as part of the Portage-Winkler study (Ringrose and Mihychuk, 1978).

The objectives of the study were:

1. To delineate and evaluate the sand and gravel resources.
2. To map the surficial geology at a scale of 1:50 000.
3. To complete the mapping of the R.M. of Portage la Prairie to aid in compiling a development plan for land use planning purposes.

BEDROCK GEOLOGY

The area is predominantly underlain by the Amaranth and Reston Formations of Jurassic Age. The bedrock includes shale, anhydrite, gypsum, limestone and dolomite. In the southeast the bedrock is Devonian shales, limestones and anhydrites of the Dawson Bay Formation and dolomites of the Winnipegosis Formation (Geological Map of Manitoba 79-2). The bedrock is overlain by 25-85 m of Pleistocene sediments (Fenton, 1970).

QUATERNARY GEOLOGY

The oldest surficial unit recognized in the area is an upper till unit which outcrops in the northeast. It is a compact pale orange coloured till (10YR 8/2) with a silty matrix and a predominantly carbonate clast content. There are two other till units, a middle and a lower till, which underlie the upper till but were not observed in outcrop. (Fenton, 1970).

Up to 22 m of lacustrine clay and silt overlies the upper till in the central and northwest portions of the study area. This lacustrine unit varies from yellowish-brown (10YR 5/4) to olive grey (5Y 4/1) in colour and is massive with silt and till clasts and stones throughout. The clast content is due to ice rafting.

There are two Lake Agassiz strandlines in the area. The first, an asymmetric ridge composed of sand, is present in the southwest. This northwesterly trending beach ridge is the Burnside Beach (Johnston, 1946) and is at an elevation of 263 m a.s.l. The ridge is curvilinear, 2-3 m high and approximately 20 m wide. To the east, a second westerly trending beach ridge at an elevation of 254 m a.s.l., part of the Stonewall Beach (Johnston, 1946), is present. This ridge is broad with very little relief (<2 m.) and comprises the only economic sand and gravel resources in the area.

Alluvium covers most of the central and southeastern portions of the area. The alluvial plain is characterized by the presence of numerous abandoned river channels that developed following the drainage of Lake Agassiz approximately 9200 yrs. B.P. (Teller and Last, 1980) and prior to 4500 yrs. B.P. when the Assiniboine River flowed into Lake Manitoba (Teller and Last, 1980).

The channels vary from 3-10 m in depth but have been largely infilled so that the present day relief is generally 2-3 m. Due to a decrease in gradient and discharge over time, the younger channels have more well developed meanders. The channels are infilled with sand, silt and clay with the older, straighter channels filled with coarser sediment. The alluvium is commonly laminated silt and clay with some iron staining or massive sandy, silty clay.

South of Lake Manitoba, seasonally submerged organic clays and silts comprise Delta Marsh. These organic deposits were laid down by the recent southward flooding of Lake Manitoba. A discontinuous present day beach is found along the south shore of Lake Manitoba.

ECONOMIC GEOLOGY

Sand and gravel resources are limited to the Stonewall beach ridge which extends into the area at the eastern boundary where approximately 2 metres of poorly sorted gravel overlies till. Extraction of the gravel is hampered by a high water table. The gravel is of medium-low quality and contains a high percentage of medium to coarse grained sand. Field counts indicate the lithology to be 70-80% carbonate clasts with 20-30% Precambrian.

Due to the scarcity of sand and gravel resources in the area, aggregate is imported from the R.M. of Woodlands.

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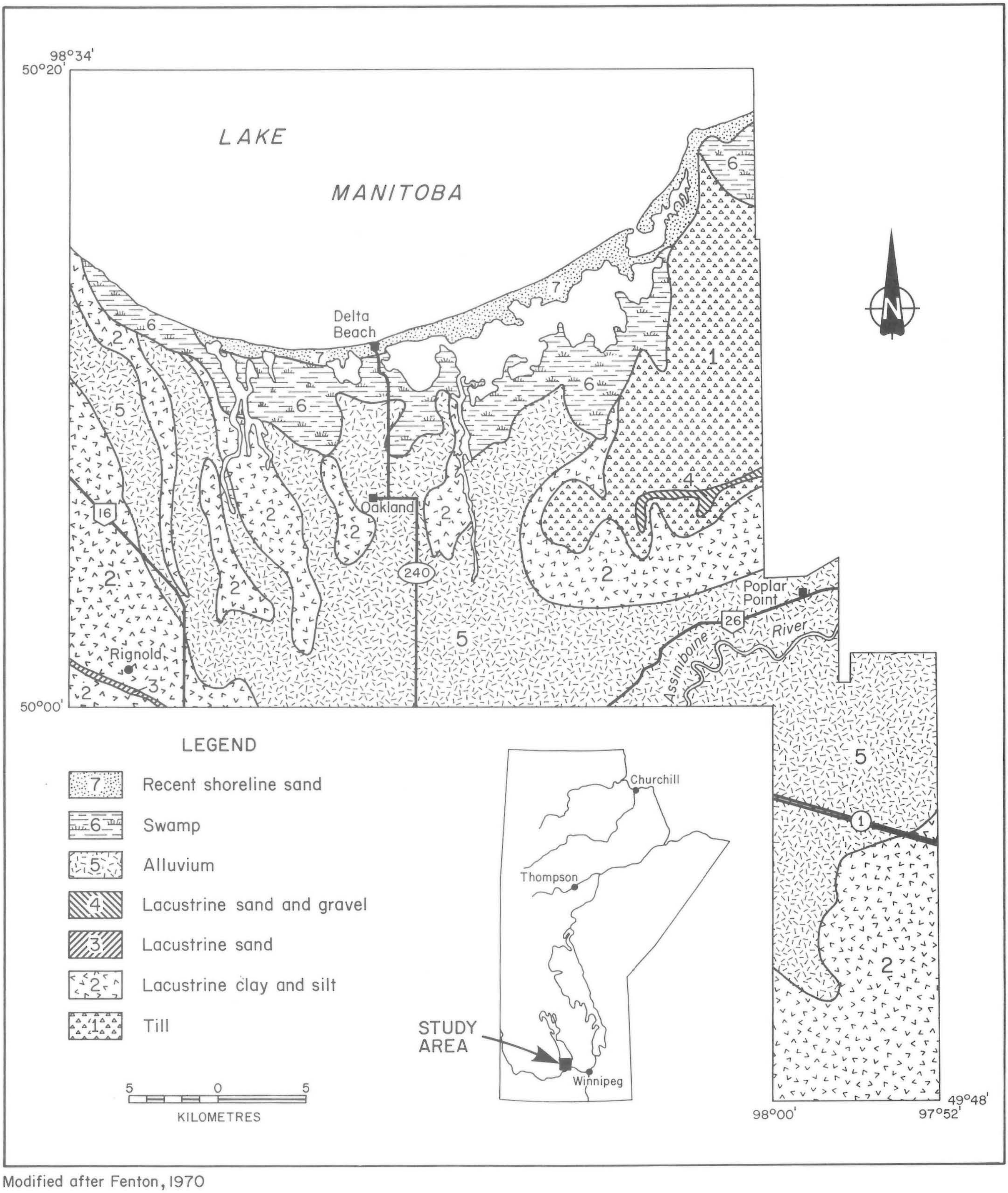

Figure AR-2-1: Surficial geology of the Delta Marsh area.

AR-3 MANTAGO RIDGE COMPLEX FISHER BRANCH AREA

by H.D. Groom

The Fisher Branch area comprises the Local Government District of Fisher and the Rural Municipality of Bifrost. It covers 3000 km^2 between Twps. 22 to 26 and Rges. 4E to 3W of the Principal Meridian. A survey of the surficial materials was begun last summer and a short account of the bedrock, Quaternary and economic geology of the area appeared in the 1981 Report of Field Activities (Groom and Jones, 1981). This year the survey was completed and a preliminary map at a scale of 1:100 000 is now available (Map FB — 1982).

Mapping of the sand and gravel resources of the area was greatly facilitated by the Materials and Research Branch of the Department of Highways and Transportation. Their backhoe program, headed by Ray Blais, involved placing test pits every 100 m along all granular deposits on Crown land and so allowed examination of ridges previously only mapped from air photos. This was especially helpful in the case of the Mantago Ridge where there were no exposures north of Twp. 25.

MANTAGO RIDGE

The informally named Mantago Ridge is the dominant feature in the study area. From south of Fisher Branch it extends northwest for 32 km and then swings north for another 9 km (Fig. AR-3-1). North of the study area, a major ridge continues northward for 35 km (Smith et al., 1975). In this area, striae and fluting directions change markedly from 140° on the west side of the ridge to 180° on the east side. The same change occurs more gradually within the study area. Till sampling, till fabric analysis and striae measurements were done to determine if the Mantago Ridge is an interlobate moraine. Results of the fabric and striae measurements are shown in Figure AR-3-1.

MORPHOLOGY

Within the study area, the morphology of the ridge changes greatly from its northern extent near Mantago Lake to its terminus south of Fisher Branch. The profiles in Figure AR-3-2 illustrate the change.

In the north, the ridge is steep sided and averages 12 m in height with a subsurface depth of at least 6 m. Minor beach ridges flank the eastern side.

The east trending ridge that joins the Mantago Ridge in Sec.30-26-3W is a tributary esker that is 10 m high, steep sided and sharp crested.

Where the Mantago Ridge trends southeast, it is 800 m wide and composed of three broad crests. The northern crest is the highest, rising 8 m above the surrounding terrain; the lowest crest is 2 m below this.

The ridge widens to 1.5 km at the southern terminus. Relief falls to 1-2 m but the subsurface depth is 13 m.

SEDIMENTS

The Mantago Ridge consists of sand and sand and gravel. The only till encountered were minor bands of flow till interbedded with the gravels in the extreme northern end of the ridge.

In the northern segment, the main ridge is comprised of cobbly coarse pebble gravel. All test pits were 5 m deep, the limit of the backhoe, and ended in granular material. However, a Manitoba Department of Water Resources drillhole in the ridge (Sec. 17-25-3W) recorded 18 m of sand and gravel without reaching bedrock. The flanking beach ridges are of interbedded sand and gravel. The lowest ridge is 2-3 m high and is underlain by stony lake clay.

In the southeast trending segment of the Ridge, gravel pits are generally 2-3 m deep and show sandy fine pebble gravel with beach bedding. In the southern terminus, 1.5 m of coarse grained sand overlies 4 m of glaciofluvial gravel and fine sand. The gravels are in foreset beds and the sands are cross-bedded.

The sediments of the east trending esker were not examined but unlike the Mantago Ridge, it is boulder strewn suggesting it was capped by till and subsequently wave-washed during the regression of Lake Agassiz.

PALEOFLOW

Paleocurrent directions were measured in gravel pits at two locations. A 5 m deep pit in the north (Sec.33-25-3W) shows fine sand in cross-beds 40 cm thick. Paleoflow directions centered around 140°. Where the ridge widens at the southern terminus, paleocurrent measurements were quite variable between units. Paleoflow was towards 270° in the lower sands, 40° in the gravels and between 30° and 150° in the upper sands.

CONCLUSION

The morphology, size, extent, sedimentary structures, paleocurrent directions and position between north and northwest striking flutes and converging striae, suggests the Mantago Ridge complex is an interlobate moraine capped and flanked by Lake Agassiz beach ridges.

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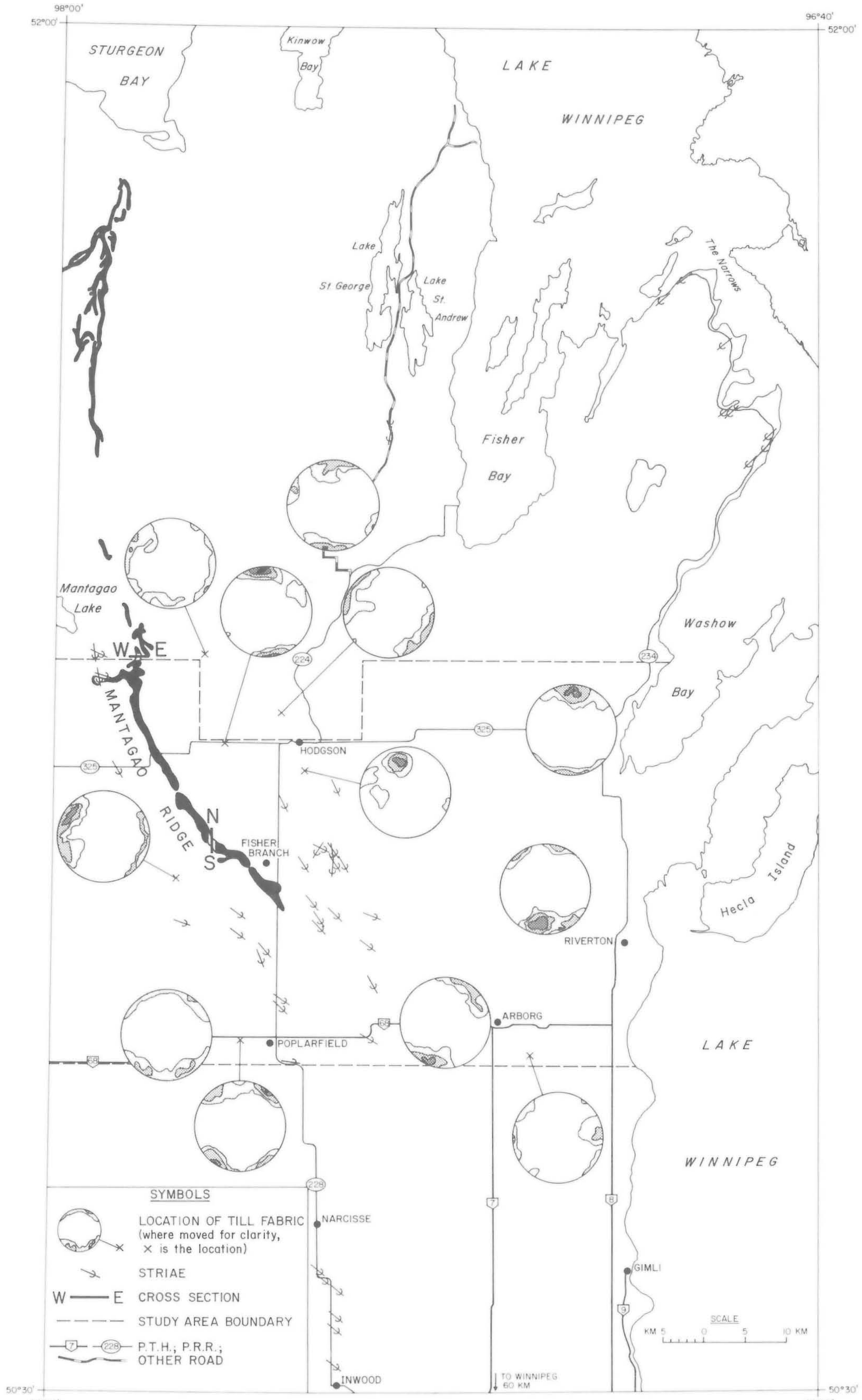

Figure AR-3-1: Map showing location of study area, the Mantago Lake Ridge, till fabric and striae direction measurements and profiles across the Mantago Lake Ridge.

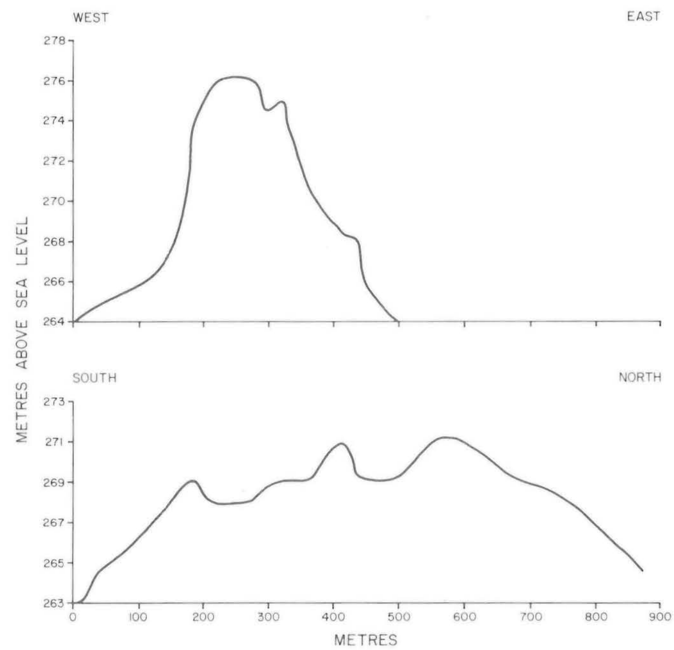

Figure AR-3-2: Profiles across the Mantago Lake Ridge. Profile locations are shown on Figure AR-3-1.

AR-4 EVALUATION OF BEDROCK FOR AGGREGATE

by C.W. Jones and B.B. Bannatyne

INTRODUCTION

This program has been initiated to determine the quality of crushed stone derived from bedrock sources in the Province. The purpose of the investigation is to provide data:

1) to evaluate the potential of selected rock units for use as aggregate;
2) fundamental to the preparation of land use planning guidelines protecting high quality bedrock from possible sterilization; and
3) for incorporation into a report on "Dolomite Resources of Manitoba".

In 1982, 17 bulk samples of carbonate rock from the Ordovician and Silurian section, exposed in quarries in the southern Interlake-Garson region, were collected. Test work on the samples is done under contract and in accordance with ASTM standards. Test results, determined by Underwood McLellan Ltd., are reported in Table AR-4-1.

CARBONATES OF THE SOUTHERN INTERLAKE AREA

The samples for testing were collected from selected quarries throughout southern Manitoba (Fig. AR-4-1). The samples represent only parts of the various members or formations, and rocks of differing quality may be present elsewhere in the unit. The specific thickness and location of each sample are listed.

Inwood Formation, Inwood quarry: — upper 2 m in north wall of central quarry; pale creamy white dense micritic 'porcelaneous' dolomite.

Inwood Formation, Inwood quarry: — lower 2 m in north wall of quarry; thin bedded, finely crystalline buff dolomite, including stromatolitic mounds; lower layer is finely fragmental dolomite.

Stonewall Formation, Stonewall quarry: — 2.65 m from northwest quarry, Stonewall, medium to thick bedded buff to yellowish buff dolomite, above 1 m layer of thin bedded rubbly dolomite.

Stonewall Formation, Stonewall pit: — 2.1 m of mottled grey and orange-grey dolomite, abundant porosity, below 0.35 m layer of purplish red and grey argillaceous dolomite and shale.

Gunton Member, Lilyfield quarry: — 1.8 m from lower part of Gunton, exposed in north wall of quarry; mottled yellowish and buff grey dolomite.

Gunton Member, Stony Mountain: — 4 m of nodular buff to brownish grey mottled dolomite, base of Gunton; from knoll and south wall, southeast of crusher.

Gunton Member, Lillies farm: — from north wall, along access road; 5.5 m of mottled yellowish and brownish grey dolomite, 1.5 m above base of Gunton.

Gunton Member, Gunton: — composite 6.85 m section from east wall and north wall, to base of Gunton; mottled nodular dolomite, with four thin layers of burrow-mottled to dense purplish dolomite.

Penitentiary Member, Stony Mountain: — 2.1 m section southeast of crusher; mottled pale greenish grey and yellowish orange argillaceous fossiliferous vuggy fragmental dolomite.

Gunn Member, Stony Mountain: — 1.6 m of upper part of unit, in pit northeast of crusher; purplish calcareous shale with three layers (6, 4 and 3 cm) interbedded grey dense limestone.

Fort Garry Member, sec. 27-13-3E quarry: — 1.5 m of vuggy, cherty, fragmental mottled dolomite, stratigraphically above red shale marker near middle of member; from northwest corner.

Fort Garry Member, sec. 27-13-3E quarry: — 2.5 m of mainly micritic dolomite, light buff, brittle, and fractured; top of sampled section is 45 cm below the base of the red shale marker; from south wall.

Selkirk Member, Winnipeg Beach quarry: — 4 m of mottled finely crystalline to granular dolomite, somewhat earthy in lower layers and vuggy in upper part, with dark brown clay patches; northwest corner.

Selkirk Member, Garson: — south wall of present quarry; 2.7 m of light buff mottled dolomitic limestone, from Tyndall stone, beds A to D.

Selkirk Member, Garson: — southeast part of present quarry; 2.8 m of light grey mottled dolomitic limestone; Tyndall stone, beds E to H.

Cat Head Member, northeast of Riverton: — 3 m of greyish and brownish buff mottled dolomite, with greyish material being massive, medium grained and hard, and surrounding brownish buff material being crumbly, with minor pin-point porosity.

Dog Head Member, Hecla Island picnic site quarry: — 3.5 m of mottled dolomitic limestone in thin flaggy beds, mostly with grey core and buff to light brown 1 cm rim.

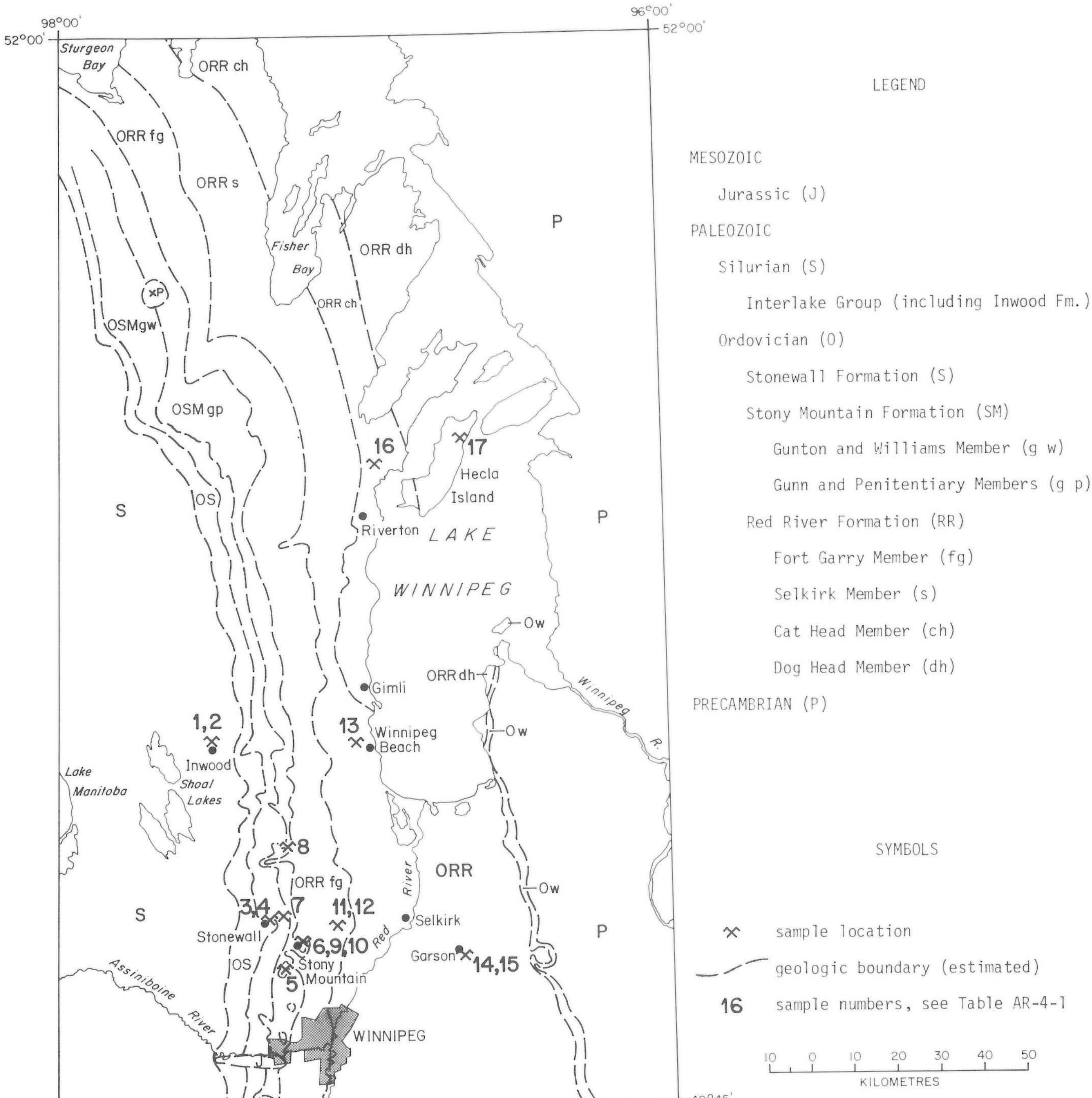

Figure AR-4-1: Sample collection sites, southern Manitoba.

Table AR-4-1. Physical properties and potential uses, Ordovician and Silurian carbonates

	1 Upper Inwood, Inwood	2 Lower Inwood, Inwood	3 Upper Stonewall, Stonewall	4 Lower Stonewall, Stonewall	5 Gunton, Lilyfield	6 Gunton, Stony Mtn.	7 Gunton Lillies	8 Gunton Gunton	9 Penitentiary Stony Mtn.	10 Gunn Stony Mtn.	11 Fort Garry Upper Mulder 12	12 Fort Garry Lower Mulder 12	13 Selkirk Winnipeg Beach	14 Selkirk A to D Garson	15 Selkirk E to H Garson	16 Cat Head Riverton	17 Dog Head Hecla Is.
Los Angeles abrasion loss	36.4%	33.5%	27%	23.8%	27.5%	27.7%	29.3%	30.3%	58.0%	45.7%	32.7%	32.5%	41.2%	51.1%	48.4%	37.1%	32.7%
Bulk Specific Gravity	2.58	2.43	2.56	2.61	2.59	2.62	2.59	2.62	2.38	2.56	2.52	2.64	2.51	2.38	2.42	2.34	2.60
Apparent Specific Gravity	2.82	2.77	2.77	2.76	2.77	2.76	2.75	2.75	2.76	2.74	2.73	2.80	2.71	2.64	2.65	2.64	2.74
Absorption	3.3%	5.1%	3.0%	2.2%	2.5%	1.9%	2.2%	1.9%	5.6%	2.6%	3.1%	2.2%	3.0%	4.0%	3.5%	4.8%	2.0%
Porosity	8.6%	12.3%	7.6%	5.6%	6.4%	5.0%	5.8%	5.0%	13.7%	6.6%	7.7%	5.9%	7.5%	9.6%	8.5%	11.2%	5.2%
Soundness Loss:																	
a) 1-1/2" to 3/4"	9.7%	7.9%	10.8%	6.4%	17.1%	4.5%	12.7%	9.6%	100%	69.5%	15.3%	23.8%	8.0%	8.0%	3.5%	7.4%	22.8%
b) 3/4" to 1/2"	11.6	17.1	10.9	6.6	16.5	5.2	13.3	10.3	100	69.8	19.8	27.2	8.3	10.4	12.2	7.3	21.5
c) 1/2" to 3/8"	26.9	29.9	22.9	16.2	27.0	8.5	20.9	15.0	100	79.8	30.7	34.2	16.8	18.6	21.3	18.5	47.7
Potential Uses:																	
Surface gravel	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Base course A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	-	Yes	Yes	Yes	-	-	Yes	Yes
Base course B	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Concrete aggregate	marg.	marg.	marg.- poor	Yes	-	Yes	Yes	Yes	-	-	marg.	-	Yes	marg.	Yes'	Yes	-
Asphalt aggregate	marg.	marg.	marg.- poor	Yes	-	Yes	Yes	Yes	-	-	marg.	-	marg.	-	-	Yes	-
Ballast	-	-	marg.- poor	Yes	marg.- poor	marg.	-	-	-	-	-	-	-	-	-	-	-

LIST OF PRELIMINARY MAPS — 1982

PRECAMBRIAN SURVEYS:

1982M	Brochet-Big Sand (64F) by D.C.P. Schledewitz and H.D.M. Cameron	1:250 000
1982W	Flin Flon-Schist Lake (Parts of 63K/12, 13) by A.H. Bailes and E.C. Syme	1:20 000
1982N-1	Walker Lake-Fairy Lake (63 I/10W½, 11E½) by J.J. Macek and F.G. Zimmer	1:50 000
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1982DM-1	Surficial Geology of the Delta Marsh Area by P. Mitchell	1:50 000
1982DM-2	Surficial Geology of the Delta Marsh Area (southeast portion) by P. Mitchell	1:50 000

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		Price
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—	A Guide to Legislation Affecting the Mineral Industry of Manitoba; 64 pages, 2 figures, 8 tables in a loose leaf 3-ring binder	$10.00
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Geological Paper GP80-1	Geology of the Metavolcanic and Volcaniclastic Metasedimentary Rocks in the Lynn Lake Area; 118 pages, 19 figures, 26 tables and 5 maps .... — H.P. Gilbert, E.C. Syme and H.V. Zwanzig	$20.00
Open File Report OF81-1	Interpretation of an Aeromagnetic Survey in the Lynn Lake Area; 115 pages, 46 figures, 9 tables and 8 maps .... — D.H. Hall, T. Millar and K.H. Mok	$ 7.50
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Open File Report OF81-5	Summary and Evaluation of the Geophysical Data from the Open Assessment Files of the Lynn Lake Greenstone Belt; 40 pages, 2 tables and 15 maps .... — I.T. Hosain	$15.00
NOVEMBER 1, 1982		
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1. Till Stratigraphy and Proglacial Lacustrine Deposits in the Winnipeg Area
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GEOLOGICAL SERVICES BRANCH

GEOLOGICAL SURVEY

Position	Personnel	Area of Current Involvement
Director	Dr. W.D. McRitchie	Manitoba
Senior Precambrian Geologist	Dr. W. Weber	Superior Province
Precambrian Geologists	Dr. A.H. Bailes	Flin Flon Belt, Rusty Lake Area
	H.D.M. Cameron	Lynn Lake region
	M.T. Corkery	Northern Superior Province. Nelson and Churchill River Corridors
	H. P. Gilbert	Island Lake and Barrington Lake
	P.G. Lenton	Churchill Province — granite and pegmatite-related projects
	Dr. J.J. Macek	Walker Lake-Setting Lake
	D.C.P. Schledewitz	Churchill Province north of latitude 57°. Molson-Kalliecahoolie Belt
	Dr. R.F.J. Scoates	Fox River region and Thompson Belt
	E.C. Syme	Flin Flon and Lynn Lake Belts
	Dr. H.V. Zwanzig	Churchill Province
Mineral Deposit Geologists	Dr. G.H. Gale	Manitoba, specifically Flin Flon and Lynn Lake
	D.A. Baldwin	Lynn Lake-Ruttan region
	Dr. P. Theyer	Island, Gods, Oxford Lakes and Bird River Sill
	Dr. M.A.F. Fedikow	Gold in S.E. Manitoba and the Lynn Lake region
Phanerozoic Geologist	Dr. H.R. McCabe	Southwest Manitoba and Interlake
Quaternary Geologist	Dr. E. Nielsen	Lynn Lake region, Interlake and southern Manitoba
Industrial Minerals Geologists	B.B. Bannatyne	Potash, peat, pegmatite minerals, lignite, limestone, and dolomite
	D.M. Watson	Silica, chromite, bentonite, building stone, gypsum, clays and shales
Mineralogist	C.R. McGregor	Island Lake

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GEOLOGICAL SURVEY

Position	Personnel	Area of Current Involvement
MINES BRANCH		
AGGREGATE RESOURCES		
Section Head	R.V. Young	Section administration — aggregate surveys Churchill, Thompson
Quaternary Geologist	G. Matile	Bird's Hill and southeastern Manitoba
	H.D. Groom	Interlake region
Resource Management Geologist	C. Jones	Bedrock evaluation and aggregate resource management
Engineering Aid	P. Mitchell	Surficial geology — Delta Marsh area

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W.D. McRitchie